vieworks

User Manual

Model : VH-5MC
VH-5MG

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Revision History

Revison	Date	Descriptoins
1.0	2010/04/23	Initial release
1.1	2010/06/28	“ssp”,”stp” command error correction , “gmn” command (4.3 section) Inserted the example of the command response(4.1 section)
1.2	2010/11/15	New Naming System

Contents

1. Precautions

General

- Do not drop or damage the device.
- Do not disassemble, repair or alter the device.
- Do not let children touch the device without supervision.
- Do not use the device for any other purpose than specified.
- Contact your nearest distributor in case of trouble or problem.

Installation & Maintenance

- Do not install the device in a place subject to direct sun light, humidity, dust or soot.
- Do not place magnets near the product.
- Do not place the device next to heating equipments.
- Be careful not to let liquid like water, drinks or chemicals leak inside the device.
- Clean the device often to remove dust on it.
- In clearing, do not splash water on the device but wipe it out with smooth cloth or towel.

Power Supply

It is recommended the use of 12V DC with ±10% of voltage, over 1A of output current with KC, CE or other local certification. (※ Vieworks Co., Ltd. DO NOT provide power supplies with the devices.)
If voltage over 16V is supplied, it will cause damages to the device.

2. Compliance & Certifications

2.1. FCC Declaration

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expenses.

2.2. CE : DoC

EMC Directive 2004/108/EC.

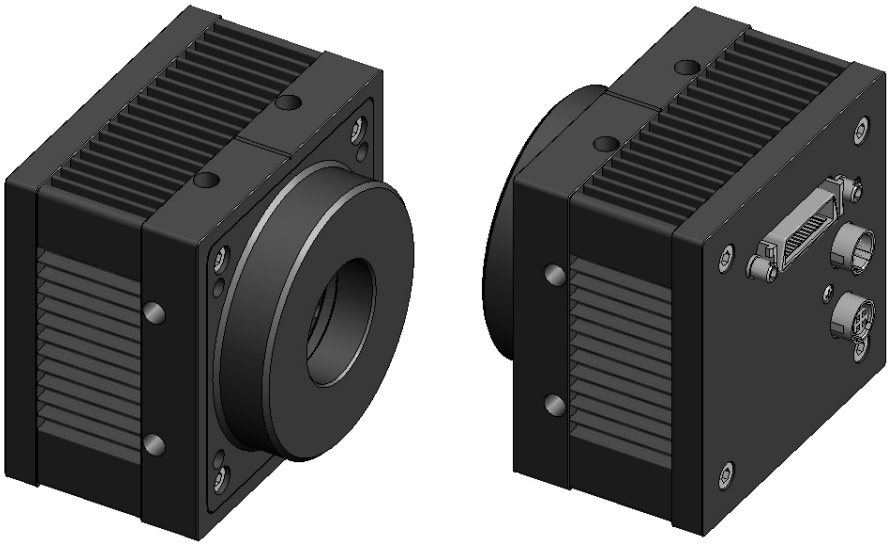
Testing Standard EN 55022:2006+A1:2007, EN 55024:1998+A1:2001+A2:2003

Class A

3. Package Contents

- Camera (1 unit)

VH Camera (C-Mount) – Camera Link



VH Camera (F-Mount) – Camera Link

VH Camera (C-Mount) – GigE Interface

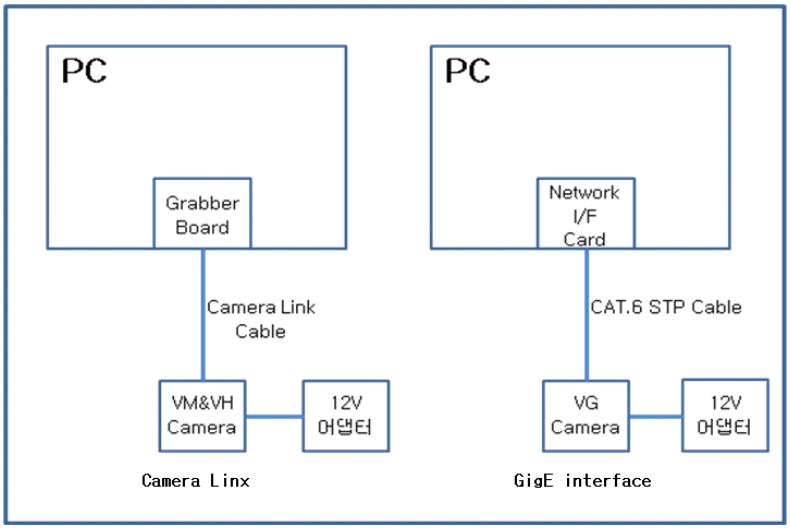
VH Camera (F-Mount) – GigE Interface

Mount Plate (OPTION)

CD

4. Installation

4.1.1. PC Connection



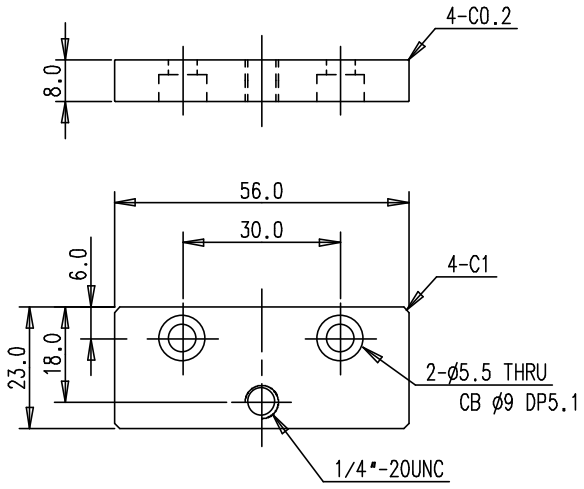
4.1.2. VH Camera (Camera Link Interface)

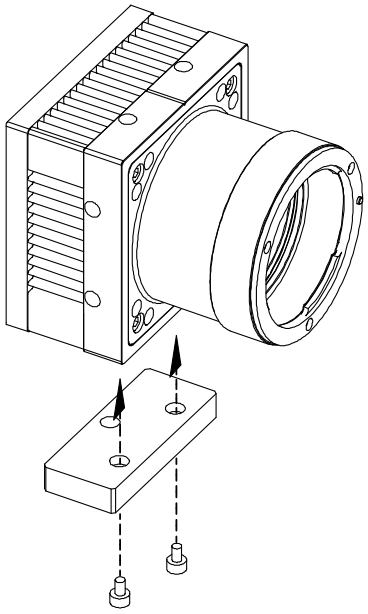
- Camera Link Cable Connection
- Power Cable Connection
- Control Cable Connection

4.1.3. VH Camera - GigE Interface

- RJ45 Cable Connection
- Power Cable Connection
- Control Cable Connection

4.1.4. Mount Plate

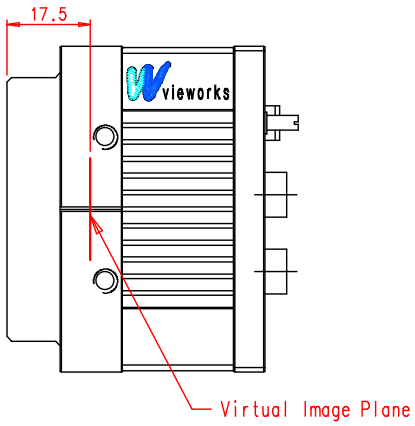




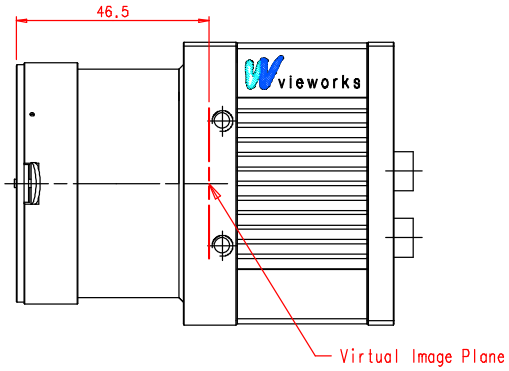
- The Mount Plate is provided as Option.
- The camera can be fix without using this Mount Plate.

5. BFL (Back Focal Length) for different Mounts

5.1.1. C-Mount



5.1.2. F-Mount



6. Overview

VH Series is a Progressive Scan type high-resolution industrial Area Scan camera. All functions of VH can be programmed and updated in the field. Image processing and control of VH are based on FPGA and 32 bit microprocessor embedded.

Main Features

- Area Of Interest
- Trigger Mode
- Binning Mode – 2 x 2 / 4 x 4
- Output Width – 8 / 10 / 12 bit
- Output Channel – 2 Tap
- Auto Taps Adjustment
- Electronic Shutter
- 2D Flat Field Correction
- Strobe Output
- Analog Gain adjustment function
- Analog Offset adjustment function
- Look Up Table
- Defective Pixel correction
- Flat Field correction
- Test Image
- Horizontal Flip
- Image Invert
- RS-644 Serial Communication
- Temperature Monitor
- Field Upgrade
- Base CameraLink (VH-5MC)
- Gigabit Ethernet (VH-5MG)

6.1. Specification

	VH-5MC	VH-5MG
Active Image	2448(H) x 2056(V)	
Sensor Type	SONY ICX625	
Pixel size	3.45 ㎛ × 3.45 ㎛	
Sensor Output	2 Tap's Output	
Video Output	8/10/12 bits, 2 Tap	
Camera Interface	Camera Link (Base)	Gigabit Ethernet
Electronic Shutter	Global Shutter	
Max Frame Rate	16 fps	
Pixel Clock	60 MHz	
Exposure Time	1/100000 sec ~7 sec (10 us step)	
Partial Scan	52 fps at 256 Lines (max. speed)	
Gamma Correction	User defined LUT	
Black Offset	Adjustable (0~127 LSB at 12 bit , 256 step)	
Video Gain	Analog Gain: 0 ~ 32 dB, 900 step	
Trigger Mode	Mode(free run , Overlap, fast, double), Programmable exposure time, Programmable trigger polarity	
External Trigger	External, 3.3V - 5.0V, 10mA, optically isolated	
Software Trigger	Camera Link CC1	-
Dynamic Range	>52 dB	
Lens Mount	C-mount, F-mount	
Power	10~14V DC , MAX. 6W	
Environmental	-5°c~+40°C , storage :-30°c~65°c	
Mechanical	68mmX68mmx54 mm, 420g (w/ C-mount adaptor) 68mmX68mmX83 mm, 460g (w/ F-mount adaptor)	

6.2. Camera Block Diagram

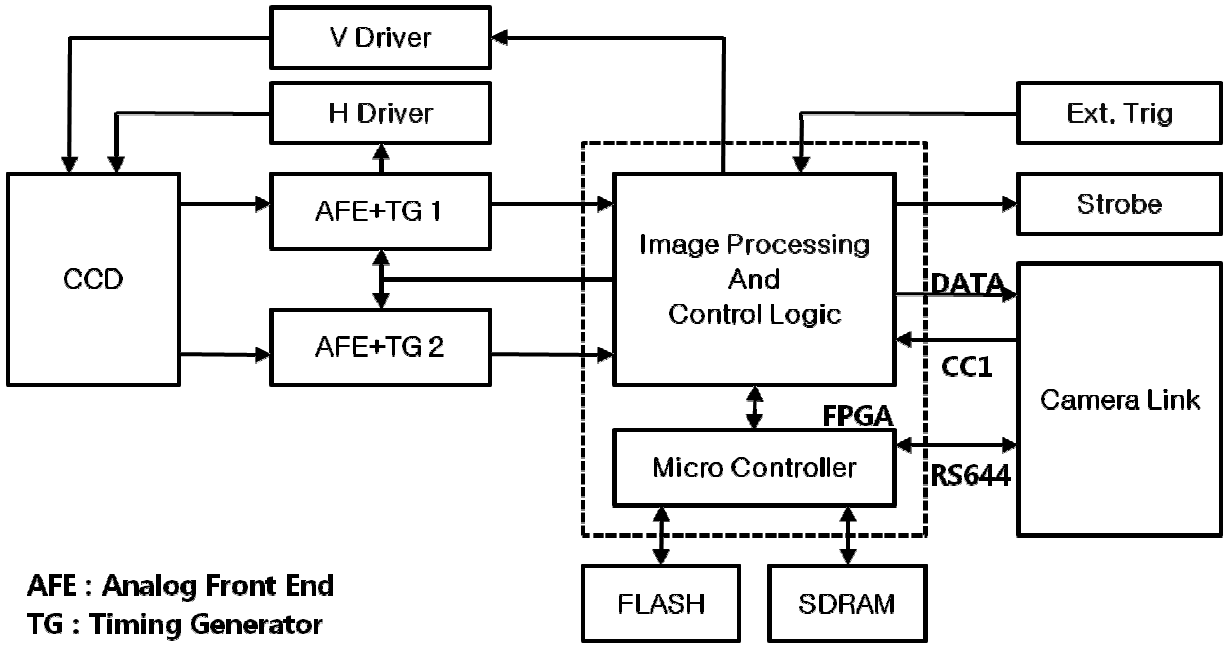


Fig 6.1 VH-5MC Camera Block Diagram

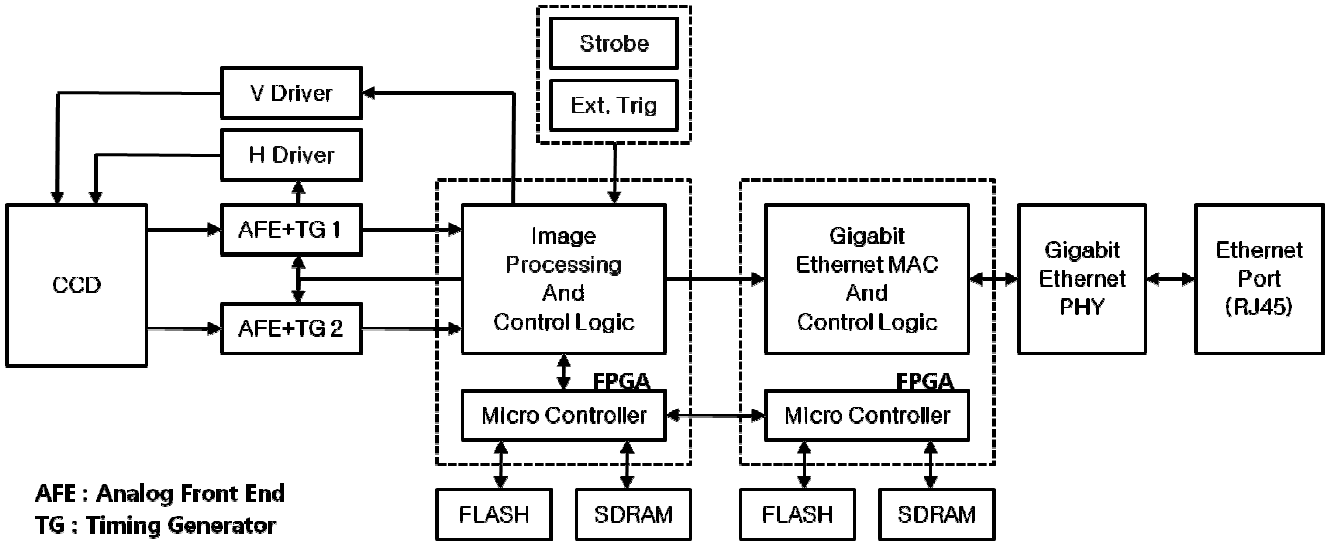


Fig 6.2 VH-5MG Camera Block Diagram

All control and data processing of camera are carried out in one FPGA chip. FPGA largely consists of Softcore type 32 bit RICS microprocessor and processing & control logic. Microprocessor receives commands from the user through Cameralink interface or Gigabit Ethernet interface and processes them. And it controls AFE chips that convert to digital value so that processing logic can accept analog CCD output and Timing Generator generating CCD control signal. Processing & control logic processes image data received through AFE, sends to Gigabit Ethernet interface, and takes charge of controlling trigger input and strobe output, sensitive to time. Besides, SDRAM for frame buffer for image processing and FLASH for operation of micro-controller are attached outside FPGA.

6.3. Sensor Information

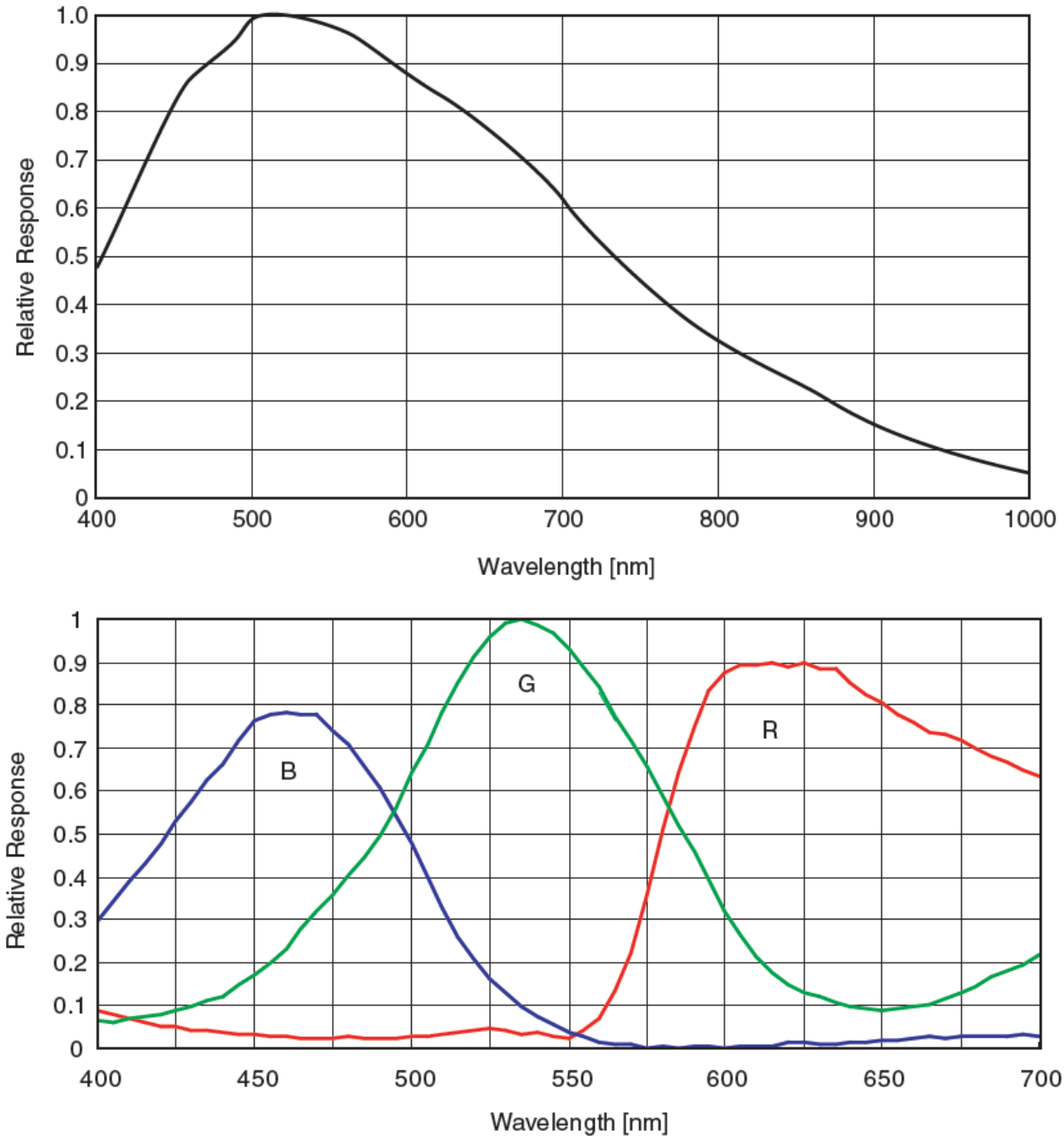


Fig 6.3 CCD Quantum Efficiency (Top :Monochrome, bottom : Color)

7. Camera Interface

7.1. General Description

As shown in the following figure, 3 types of connectors and status indicator LED are located on the back of the camera and have the functions as follows:

- 6 pin Power Input Connector : camera power input,
- 4 pin Control Connector : external trigger signal input and Strobe output
- 26 pin Camera-Link Connector : video data transmission, camera control
- Status LED : power and operation mode display

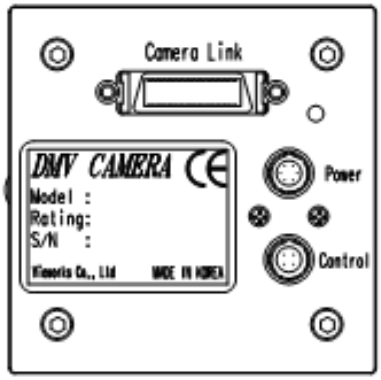


Fig 7.1 VH-5MC Series Connectors

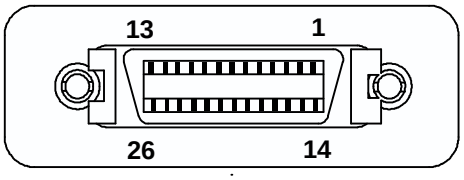


Fig 7.2 CameraLink Connector

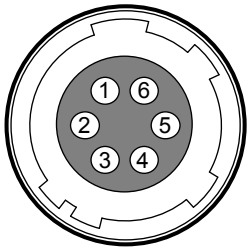
Camera output complies with Camera Link Standard and following list shows the pin configuration of connector.

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	-X0	LVDS - Out	Camera Link Transmitter
	15	+X0	LVDS - Out	Camera Link Transmitter
PAIR 2	3	-X1	LVDS - Out	Camera Link Transmitter
	16	+X1	LVDS - Out	Camera Link Transmitter
PAIR 3	4	-X2	LVDS - Out	Camera Link Transmitter
	17	+X2	LVDS - Out	Camera Link Transmitter
PAIR 4	5	-X3	LVDS - Out	Camera Link Transmitter
	18	+X3	LVDS - Out	Camera Link Transmitter
PAIR 5	6	-XCLK	LVDS - Out	Camera Link Transmitter
	19	-XCLK	LVDS - Out	Camera Link Transmitter
PAIR 6	7	- SerTC	LVDS - In	Serial Data Receiver
	20	+ SerTC	LVDS - In	Serial Data Receiver
PAIR 7	8	- SerTFG	LVDS - Out	Serial Data Transmitter
	21	+ SerTFG	LVDS - Out	Serial Data Transmitter
PAIR 8	9	- CC 1	LVDS - In	Software External Trigger
	22	+ CC 1	LVDS - In	Software External Trigger
PAIR 9	10	N/C	N/C	N/C
	23	N/C	N/C	N/C
PAIR 10	11	N/C	N/C	N/C
	24	N/C	N/C	N/C
PAIR 11	12	N/C	N/C	N/C
	25	N/C	N/C	N/C
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 7.1 Pin Assignents for Camera Link Base Configuration

7.2. Power Input Connector

Power input connector of camera is Hirose 6 pin connector(part # HR10A-7R-6PB). Pin arrangement and configuration are as follows:



< Pin Arrangement of Power Input Connector >

Pin Number	Signal	Direction	Function
1, 2 , 3	+ 12V DC	Input	DC Power Input
4 , 5 , 6	DC Ground	Input	DC Ground

Table 7.2 Pin Configuration of Power Input Connector

Power plug can be configured using the Hirose 6 pin plug (part # HR10A-7P-6S) or compatible parts enclosed in the camera box. For power supply, it is recommended to use the power adapter twith over 1A current output at 12VDC ±10% voltage output.

Cautions for Power Input

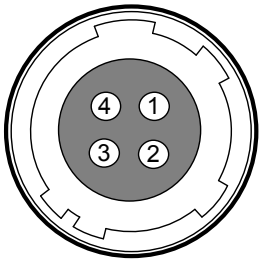
Make sure to connect the power wiring of camera after checking the camera input power is turned off. If not, it may result in damage of camera.

If the voltage over 16V is applied beyond the power voltage input of camera, circuit inside camera can be damaged.

7.3. Control Connecter

control connector is Hirose 4 pin connector(part # HR10A-7R-4S) and consists of external trigger signal input and strobe output port. Pin arrangement and configuration are as follows:

.



< Pin Arrangement of Control Connector >

Pin Number	Signal	Direction	Function
1	Trigger Input +	Input	
2	Trigger Input -	Input	
3	DC Ground	-	DC Ground
4	Strobe Out	Output	3.3V TTL Output Output resistance : 47 Ω

Table 7.3 Pin Arrangement of Control Connector

Matching plug connector can use Hirose 4 pin plug(part # HR10A-7P-4P) or equivalent connector.

7.4. Trigger Input Circuit

Following figure shows trigger signal input circuit of 4 pin connector. Trigger signal entered is delivered to internal circuit through photo coupler. Minimum trigger width that can be recognized at camera is 1us. If trigger signal entered is less than 1us, trigger signal is ignored in camera. External trigger signal can approve signals to the circuits in the 2 methods shown below.

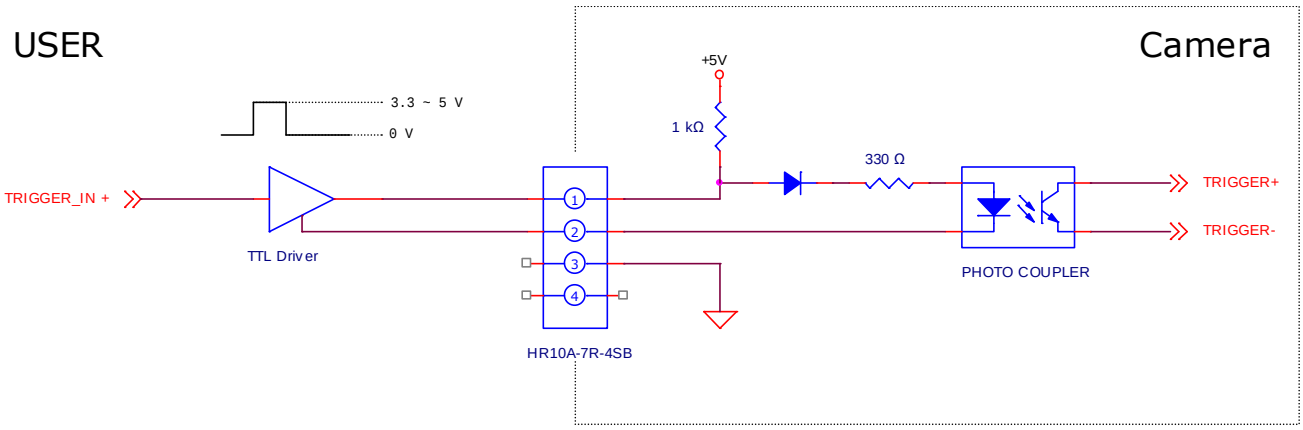


Fig 7.3 Trigger Input Schematic 1

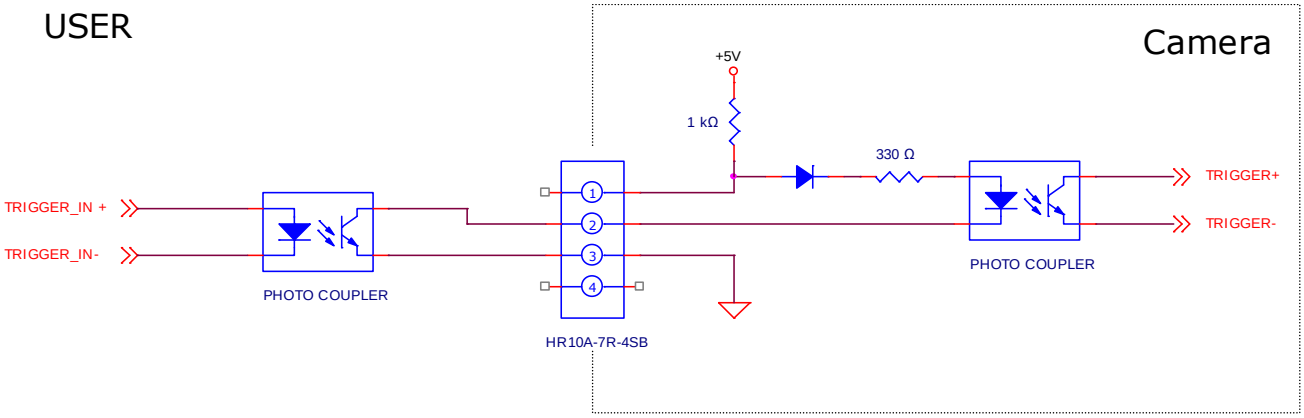


Fig 7.4 Trigger Input Schematic 2

7.5. Strobe Output Circuit

Strobe output signal is output through TTL Driver IC of 3.3 V output level and pulse width of signal is output in synchronization with exposure of camera.

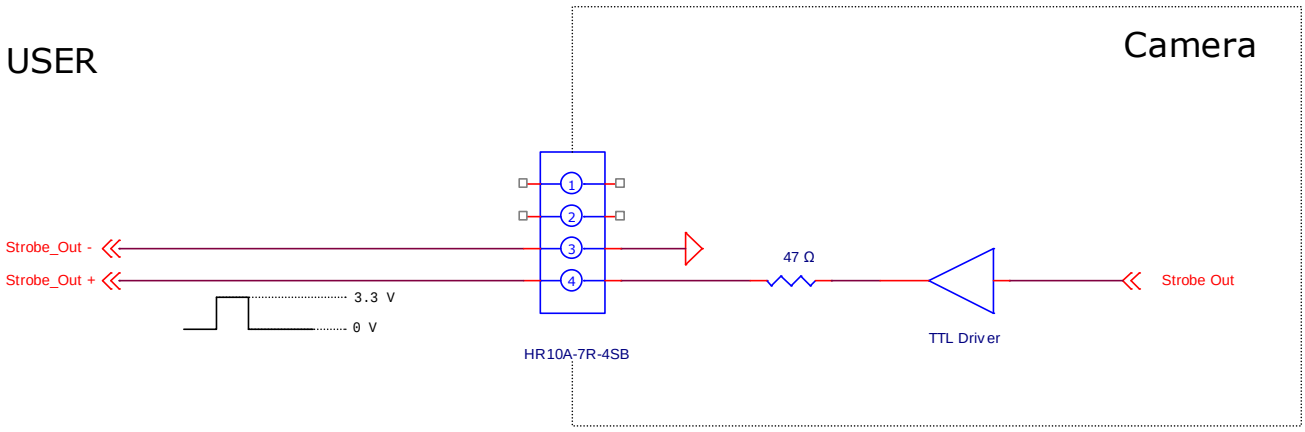


Image 7.1 Strobe Out Schematic

8. Camera Features

8.1. Area Of Interest (AOI)

AOI is the area containing the data required by the user among total areas of image. The user can obtain the image faster, with the quality same as when obtaining overall areas by designating the area as AOI when part of area is required in all areas. AOI is determined as the overlapping area of 2 areas when designating Start point and End point in horizontal and vertical direction as shown in Fig 8.1. Start point and End point mean the starting and end of the area. The narrower Vertical AOI gets, the faster the frame speed. But Horizontal AOI does not affect frame speed.

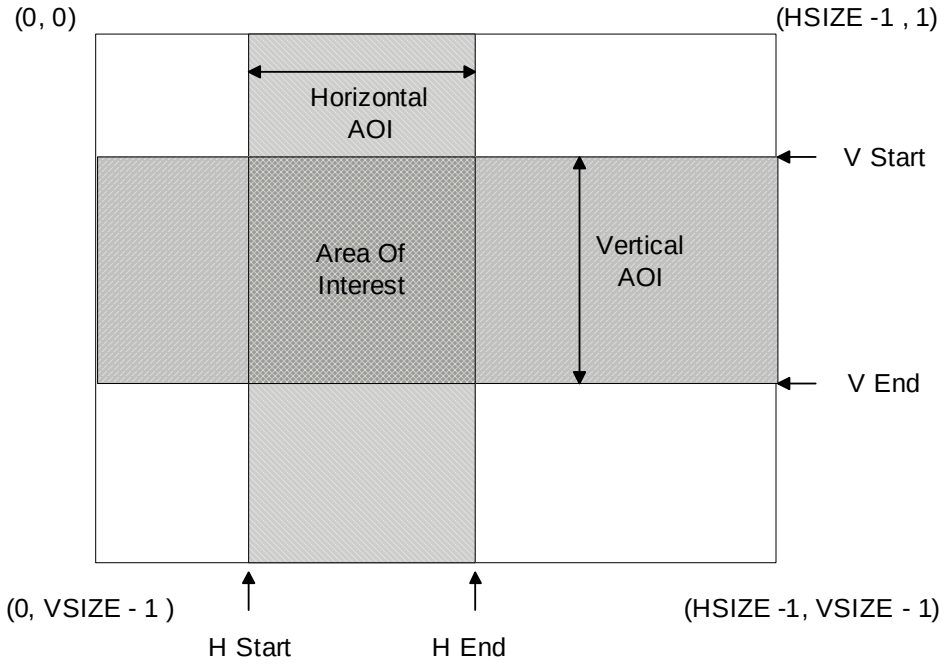


Fig 8.1 AOI

Maximum frame speed depending on change of Vertical AOI can be obtained as shown in the following expression.

$$\text{Frame Rate (fps)} = 1000000 / (T_{VCCD} + T_{FD} \times (VSIZE - VAOI) + VAOI \times T_L)$$

T_{VCCD} : time required to move electric charges accumulated on pixel to Vertical Register

T_{FD} : time required for Fast Dump

VSIZE : number of Vertical Line of CCD

T_L : time required for transmission of one line

VAOI : size of Vertical AOI

	VH-5MC	VH-5MG
T_{VCCD}	19.1 us	
TL (2 channel)	30.1 us	
TFD	10 us	
VSIZE	2056 Lines	
Minimum Vertical AOI Size	256 Lines	

Table 8.1 Timing Value per Model

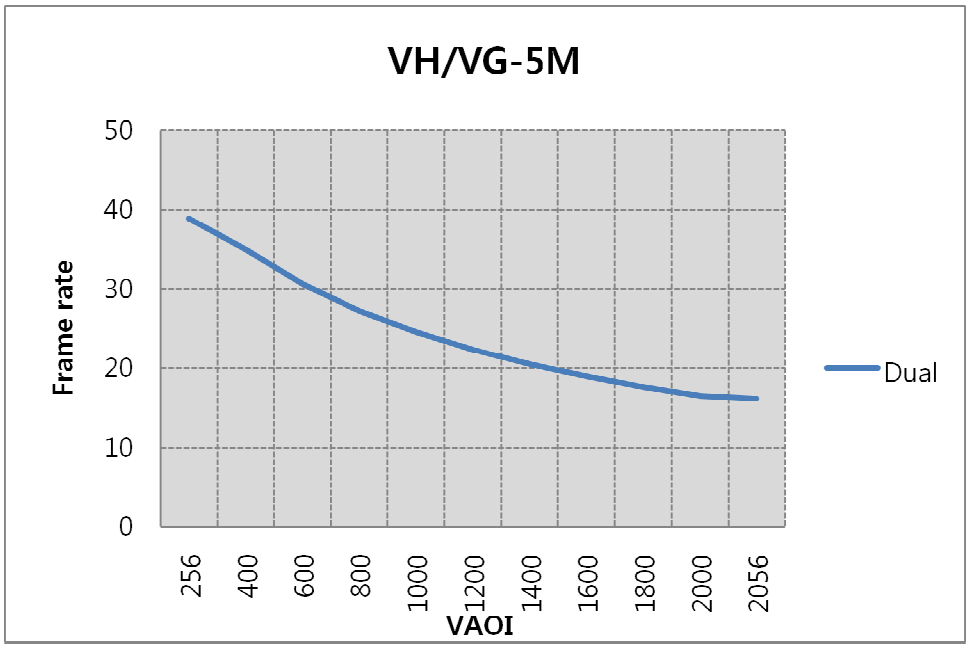


Fig 8.2 Frame Rate Change by VAOI

8.2. Binning

Binning has the effects of increasing the level value and decreasing resolution by adding value of adjacent pixel and sending them as one pixel. Camera applies same Binning Factor(2 or 4) to both directions in order to keep the percentage of image. Fig 8.3 and Fig 8.4 show application of 2x2 Binning and 4x4 Binning, respectively. Since Binning in vertical direction is processed at internal register of CCD, the frame speed increases as many as Binning Factor if Binning is applied, but Binning in horizontal direction does not affect frame speed. Binning Factor is set using “sbf” command.

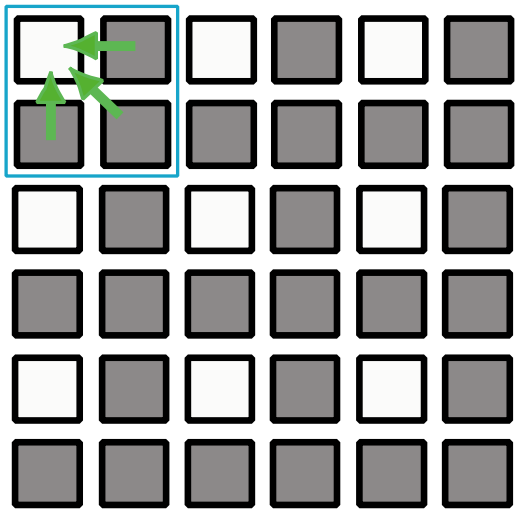


Fig 8.3 2x2 Binning

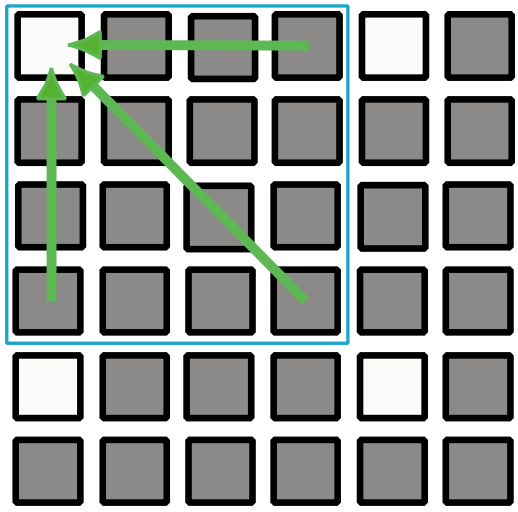


Fig 8.4 4x4 Binning

8.3. Trigger

8.3.1. Trigger Input

Trigger mode of camera is divided into Trigger synchronous mode and Trigger asynchronous mode(hereinafter "Free-Run mode") depending on its synchronization with trigger input. Trigger synchronous mode is divided into Standard mode, Double Exposure mode, Fast mode, Overlap mode, depending on concrete operation type.

It is required to set the trigger first to operate camera in Trigger synchronous mode. In concrete, it is required to select which one of CC1 port and TRIGGER_IN port should be used as trigger input and to set whether polarity of trigger should be Positive or Negative.

8.3.2. Free-Run Mode

Free-Run Mode repeats Readout depending on parameter value set in camera currently, regardless of trigger input.

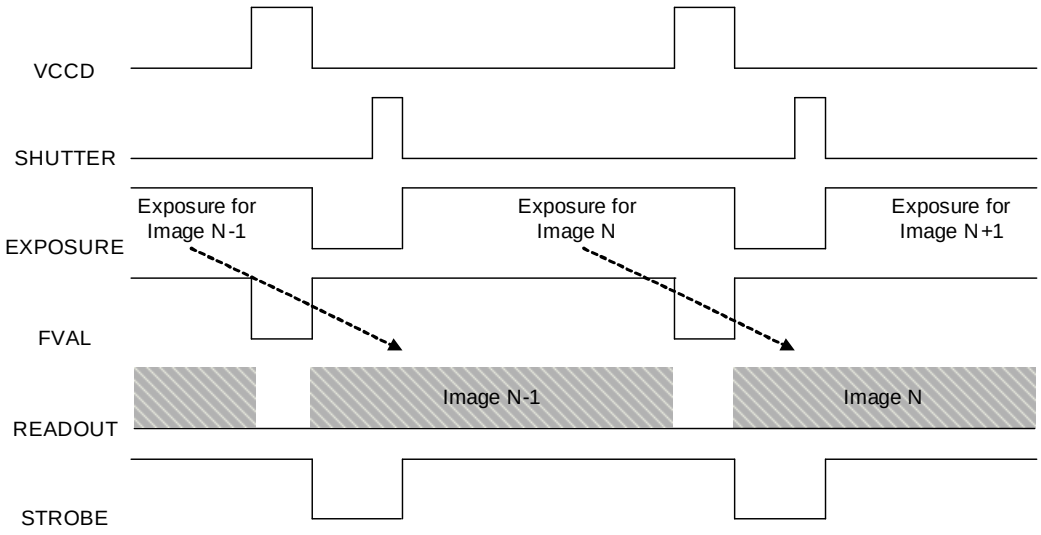


Fig 8.5 Free-Run Mode

As shown in Fig 8.5, Readout section overlaps with exposure section of next image in Free-Run Mode. At this time, camera operation slightly differs depending on length of Exposure Time and Readout time. If Exposure Time is shorter than Readout, Shutter signal occurs during readout, and when Readout finishes, Readout of next image starts.(Fig 8.6) In this case, frame speed is constant regardless of change in Exposure Time. But if Exposure Time is set longer than Readout time, Shutter signal occurs together with start of Readout and Readout of next image does not start until Exposure Time set elapses even if Readout finishes.(Fig 8.7) In this case, frame speed gets lower as the setting value of Exposure Time increases.

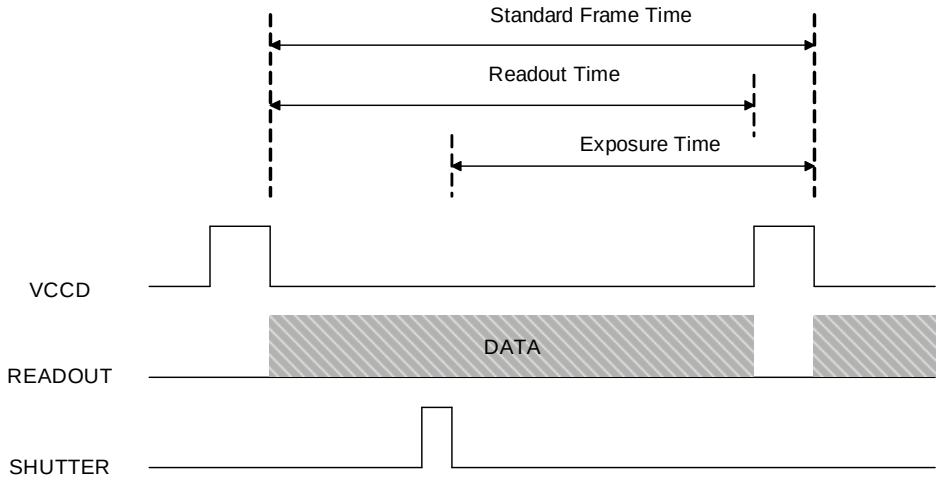


Fig 8.6 If Exposure Time is Shorter than Readout Time

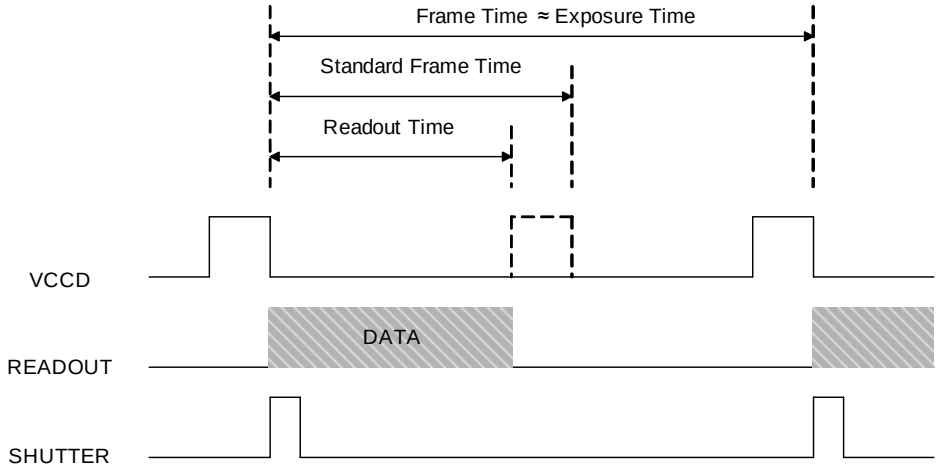


Fig 8.7 If Exposure Time is longer than Readout Time

8.3.3. Standard Mode

In Standard Mode, camera keeps standby status until trigger signal is entered, and when trigger input occurs, Readout start after Exposure process set earlier. After Readout is completed, and returns to trigger standby status again. In Standard Trigger mode, if a new trigger input occurs during readout, the new trigger input is ignored.

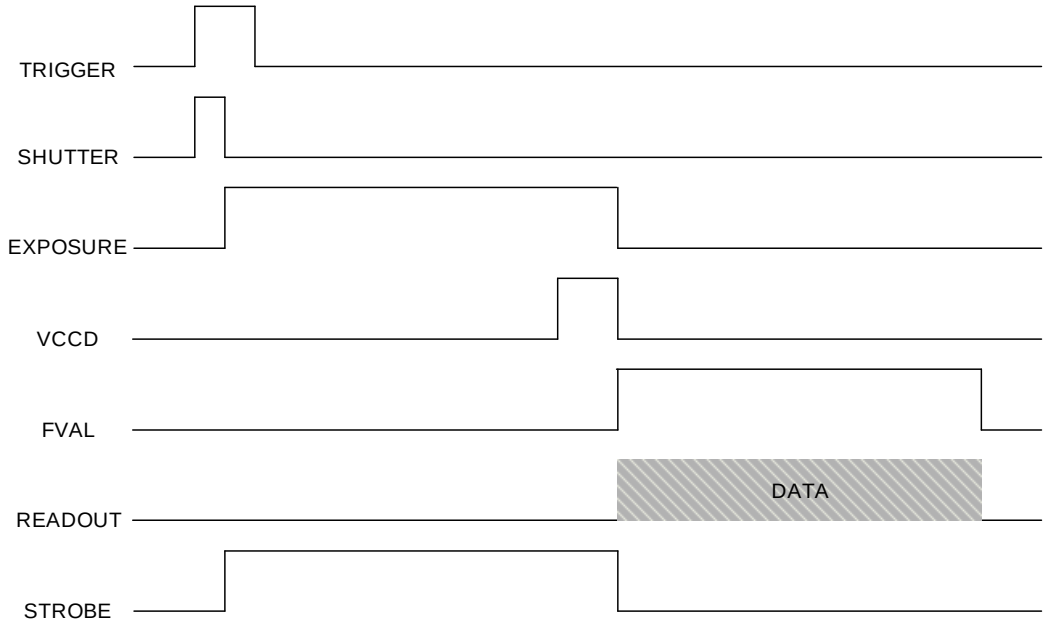


Fig 8.8 Standard Trigger Mode

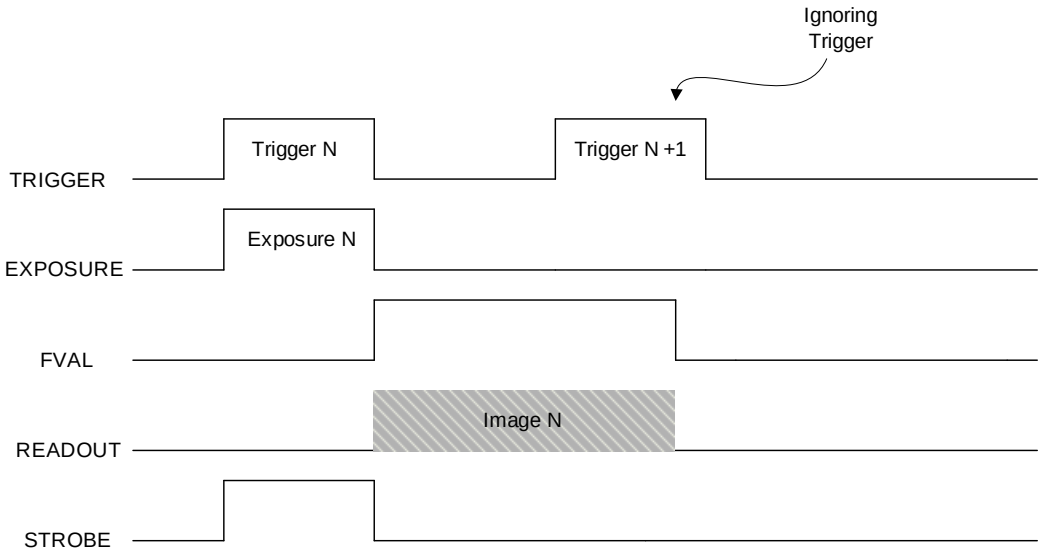


Fig 8.9 Retriggering

8.3.4. Double Exposure

In Double Exposure mode, 2 images are obtained with 1 trigger input. When trigger input is entered in this mode, the camera starts Readout after passing through exposure process according to exposure setting as in Standard mode. At this time, exposure of second image starts with Readout. When Readout is completed, the camera performs the second Readout. Since it does not generate shutter signal during Readout of the 1st image, the interval between completion of 1st exposure and starting of 2nd exposure is as short as several us ~ several decades us.

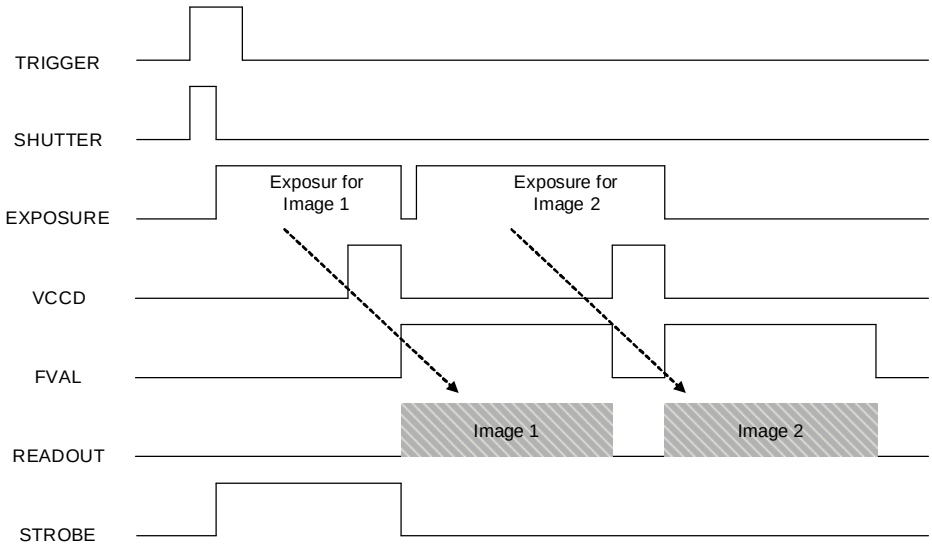


Fig 8.10 Double Exposure Trigger Mode

8.3.5. Fast Mode

Fast Mode is used when interval of trigger input is faster and more continuous than in Standard Mode. Its difference from Standard Mode is that while Readout starts in exposure time as set earlier when trigger input occurs in Standard Mode, while Readout immediately starts after trigger input in Fast Mode. And Interval between triggers becomes the exposure time of image since it does not generate shutter signal during Readout.

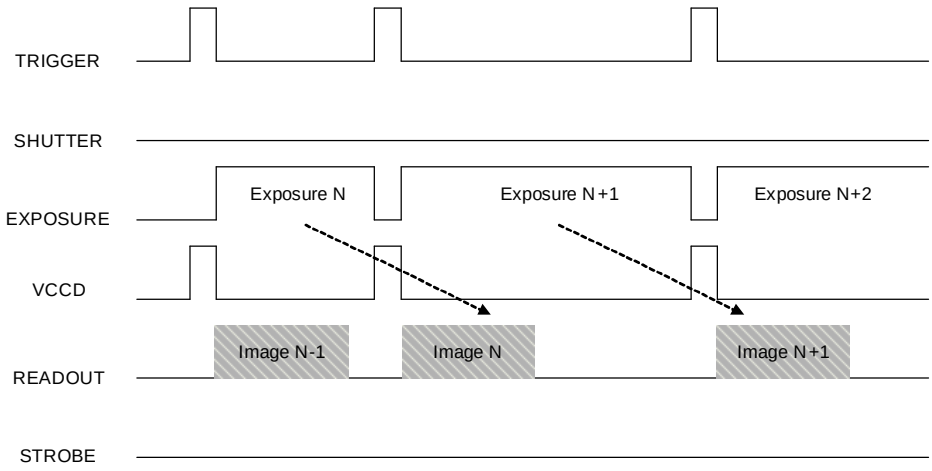


Fig 8.11 Fast Trigger Mode

8.3.6. Overlap Mode

Camera keeps standby status until trigger signal is entered like in Standard Mode, and Readout starts after exposure process set earlier if trigger input occurs. When new trigger input occurs during Readout of First image, it keeps Readout and pass exposure process of new trigger input. Provided, however, that when trigger input occurs during Exposure since Exposure Time is longer than trigger interval, that trigger signal is ignored. To obtain the image as maximum frame for trigger input, Exposure Time should not be longer than Readout time, trigger time should not be shorter than Readout time. Readout time for VH-5M Camera is 62.1us.
In addition, overlap mode operates ideally when trigger signal interval or exposure time is constantly kept.

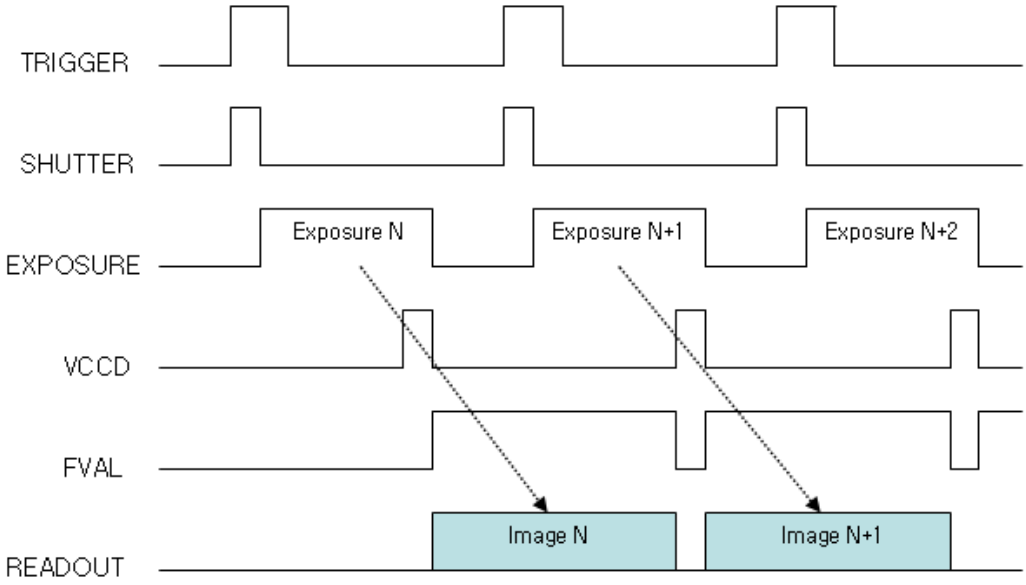


Fig. 8.12 Overlap Trigger Mode

8.4. Channel Mode

When reading data from Horizontal Register of CCD, it read in Dual Channel. Pixel values left to the center of Horizontal Register come through Video A, and pixel values to the right come through Video B.

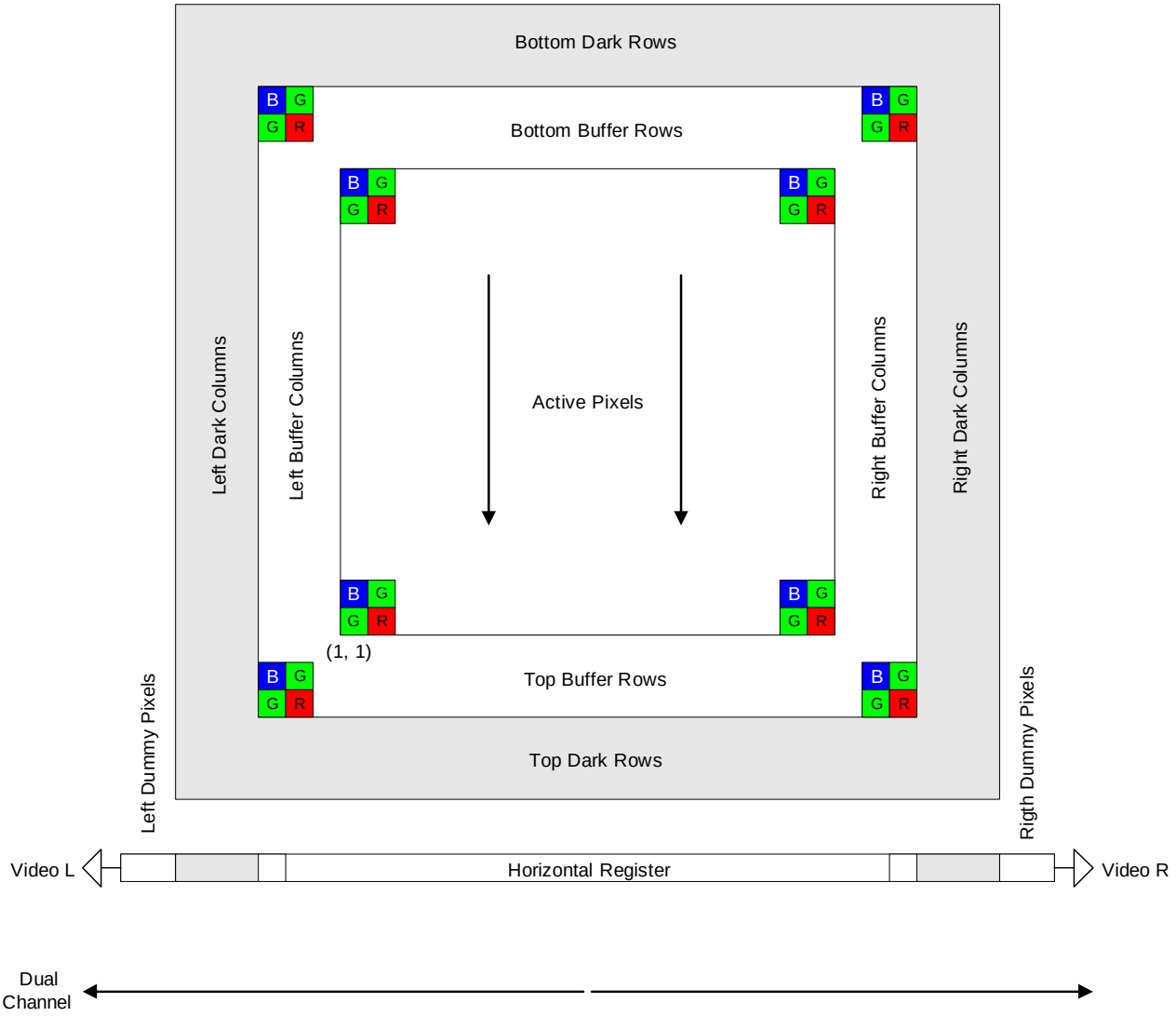


Fig 8.13 Channel Mode

The output images from CCD, after being processed, get rearranged for generating image output compliant to Camera Link standard. image data transmitted simultaneously through Video L and Video R is output in A, B Interleaved type through image processing and rearrangement (Fig 8.15)

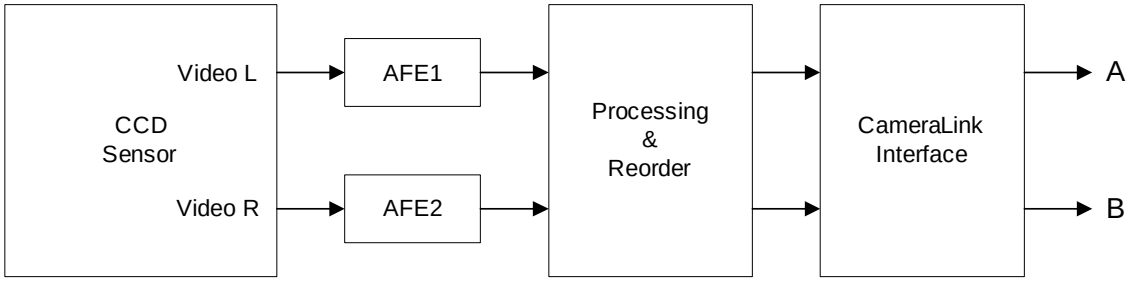


Fig 8.14 Image Data Flow

Fig 8.15 Data Out

8.5. Gain and Offset

The camera has one Analog Signal Processor (or Analog Front End, abbreviated to AFE) for each channel. This AFE operates in 50MHz and consists of Correlated double Sampler(CDS), Variable Gain Amplifier(VGA), Black Level Clamp and 14-bit A/D converter. AFE has register for Gain and Offset application inside, and can change Gain and Offset value by entering proper value in the register. Gain can be set between 0 ~ 899 and relation between set value and actual Gain(dB) is as follows:

Gain(dB) = (Setting value X 0.0358dB)

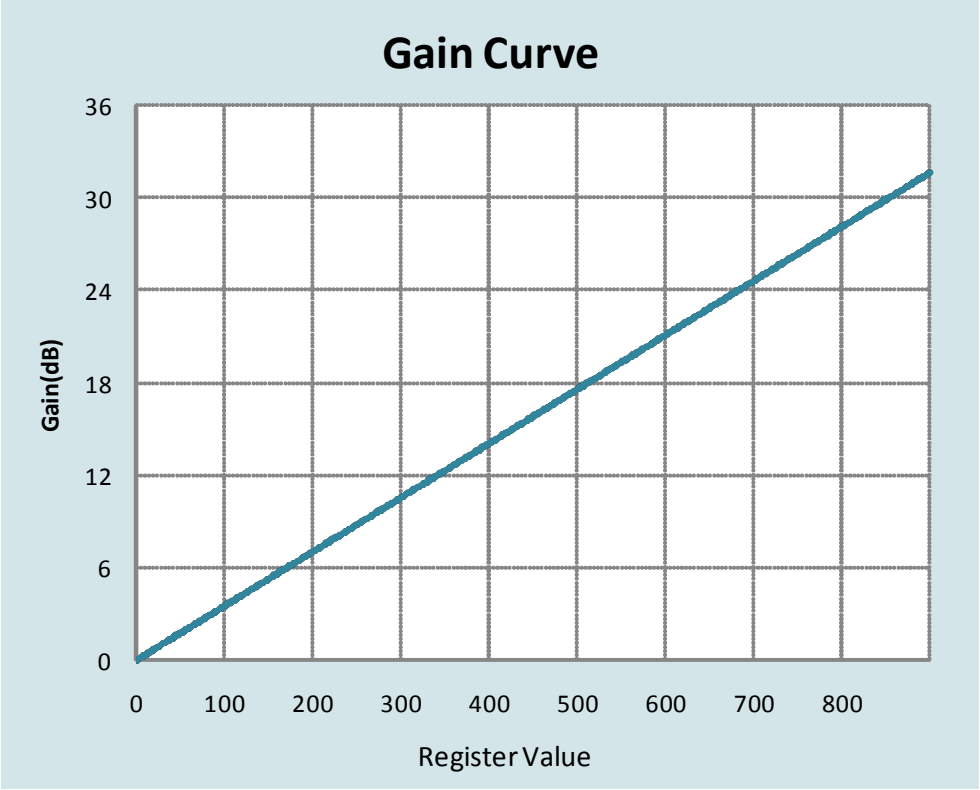


Fig 8.16 Register Setting vs Gain

Offset can be set between 0 ~ 128 (LSB @12bit)

8.6. LUT

LUT(Lookup Table) converts original image value to certain level value. Since it is mapped one to one for each level value, 12-bit output can be connected to 12-bit input. LUT is in the form of table that has 4096 entries between 0~4095 and provides 2 non-volatile spaces for LUT data storage. User can select whether to apply LUT or not and the LUT to be applied using “sls” command. See Appendix B for how to download LUT data in camera.

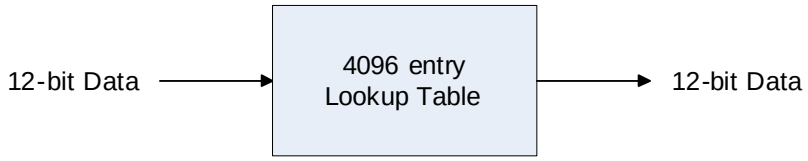


Fig 8.17 LUT Block

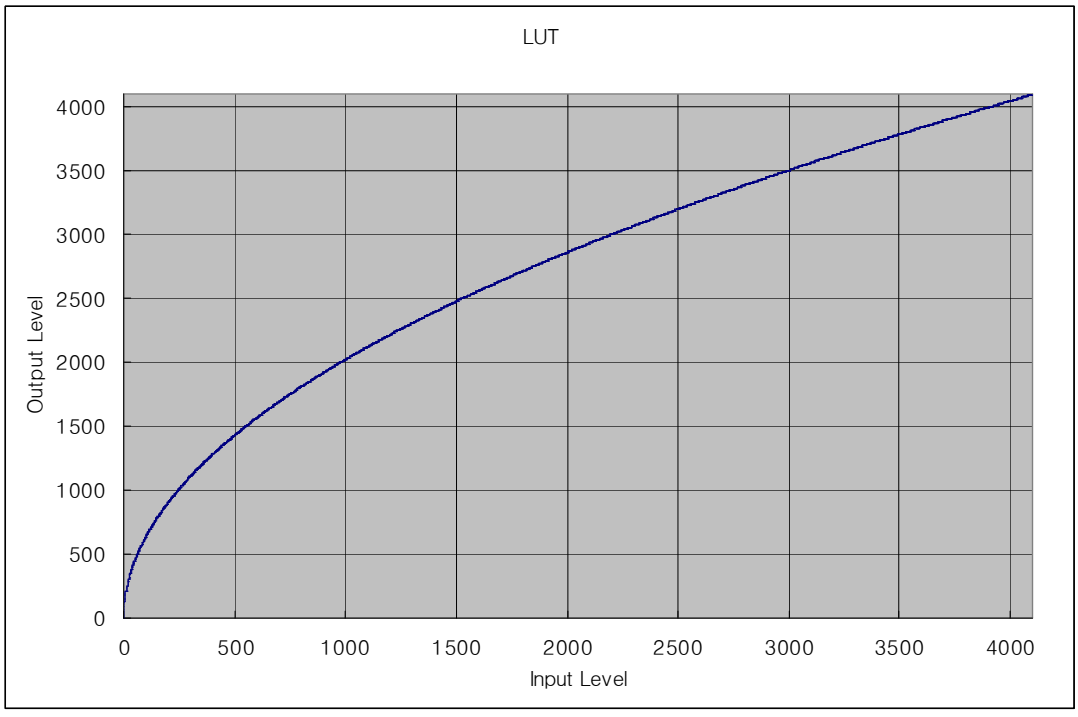


Fig 8.18 LUT at Gamma 0.5

8.7. Defective Pixel Correction

There is Defective Pixel in CCD, which cannot properly react to the right. Correction is required since it may deteriorate the quality of output image. Defective Pixel information of CCD used for each camera is entered in the camera at the phase of forwarding from the factory. If the user wants to add Defective Pixel information, it is required to enter coordinate of new Defective Pixel in camera. See Appendix A for details. “sdc” command is used to set whether to use Defective Pixel Correction function.

8.7.1. Correction Method

Correction value of Defective Pixel is calculated based on valid pixel value adjacent in the same line.

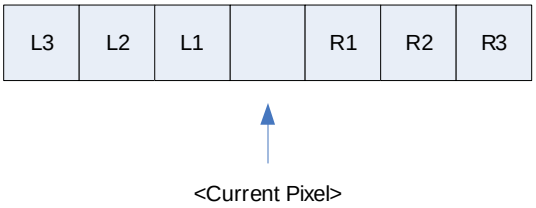


Fig 8.19 Location of Defective Pixel to be Corrected

If there is Current Pixel, Defective Pixel to correct the value as shown in Fig 8.19, correction value of this pixel is obtained as shown in the following Table 8.2 depending on whether surrounding pixel is Defective Pixel or not.

Adjacent Defective Pixel(s)	Correction value of Current Pixel
NO	(L1 + R1) / 2
L1	R1
R1	L1
L1, R1	(L2 + R2) / 2
L1, R1, R2	L2
L2, L1, R1	R2
L2, L1, R1, R2	(L3 + R3) / 2
L2, L1, R1, R2, R3	L3
L3, L2, L1, R1, R2	R3

Table 8.2 Calculation of Defective Pixel Correction Value

8.8. Flat Field Correction

Flat Field Correction is a function which guarantees a certain level of image quality when lights and other external elements deter the background of the image. The Flat Field Correction function can be summarized into the following equation:

IC = {(IR – IB) x M } / (IF – IB)

Where,
IC : Level value of corrected image;
IR : Level value of original image;
IB : Black offset value;
M : Offset value of image after correction;
IF : Level value of Flat Field data.

In order to use the Flat Field Correction function, one must first generate IF, the Flat Field data. This can be done by adjusting the camera to the environment and activate the Flat Field Generator. The Flat Field Generator will standardize a series of images, curtailing the image to a ratio of 1/64, generate the curtailed Flat Field data, and store it in the external frame buffer. When curtailed images are used for corrections, it is expanded and applied with a Bilinear Interpolation as shown in Fig 8.21. When the Flat Field data is generated, use the “sfo” command to set the M value, and use the “sfc” command to apply the Flat Field Correction. Here, the Flat Field data is stored on the RAM, a volatile memory. In order to reuse the stored data, the “sdf” command must be used to store them on the FLASH, a non-volatile memory.

<Caution>
1. The activation of the Flat Field Generator will ignore the current value and will temporarily operate under the following default conditions. When the generation of the Flat Field data is complete, the original setting of the camera will be restored.

- Readout Mode : Normal
- Trigger Mode : Free-Run
- Channel Mode : Single
- Defective Pixel Correction : ON

2. The offset value M is based on the Normal Readout mode. According to the AOI mode, Binning mode, or Dual Channel mode, the offset value of an actual image is expressed differently.

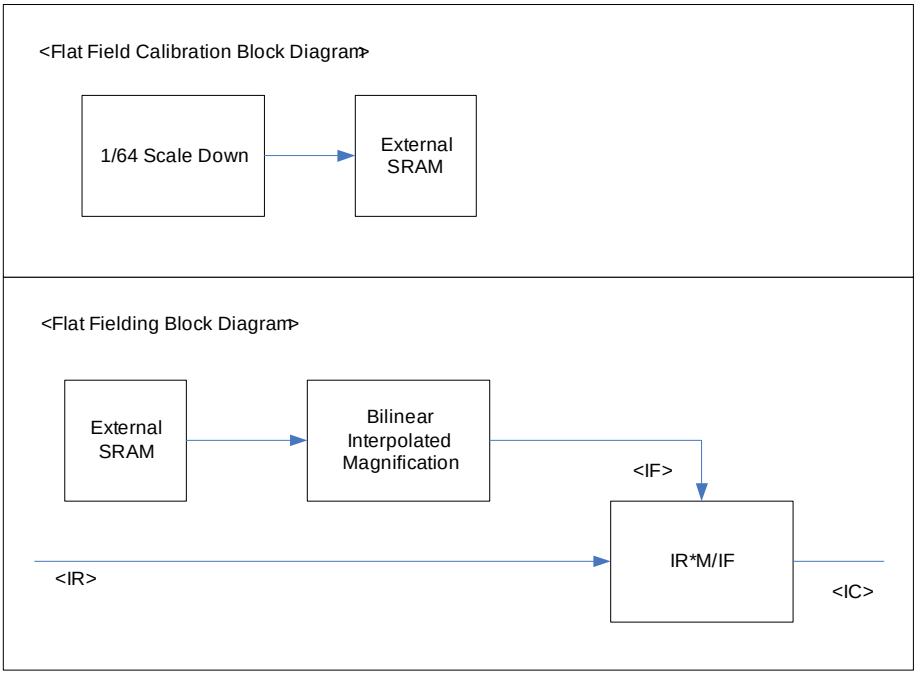


Fig 8.20 Generation and Application of Flat Field Data

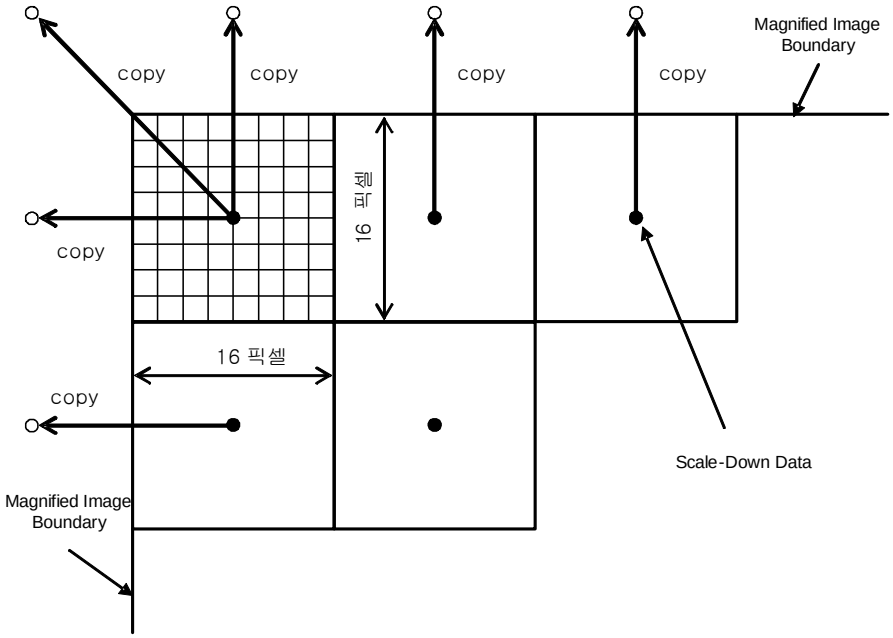


Fig 8.21 Bilinear Interpolated Magnification

8.9. Temperature Monitor

Sensor chip is embedded in camera to monitor the internal temperature. “gct” command is used to check the temperature of camera.

8.10. Status LED

There is green LED to inform the operation status of camera on the back of camera. LED status and corresponding camera status are as follows:

- **Continuous ON status** – camera operates in Free-Run Mode.
- **Repeat ON for 0.5 seconds, OFF for 0.5 seconds** – camera operates in Trigger Mode.
- **Repeat ON for 1 second, OFF for 1 second** – Test Image is output.
- **Repeat ON for 0.25 second, OFF for 0.25 second** – operates in Trigger Mode and Test Image is output.

8.11. Data Format

Data can be processed in the unit of 14 bit internally, but can be selectively output in the unit of 8, 10, 12bit at output. When it is output in 8bit and 10bit unit, lower 4 bit and 2 bit are cut out from overall 12bits.

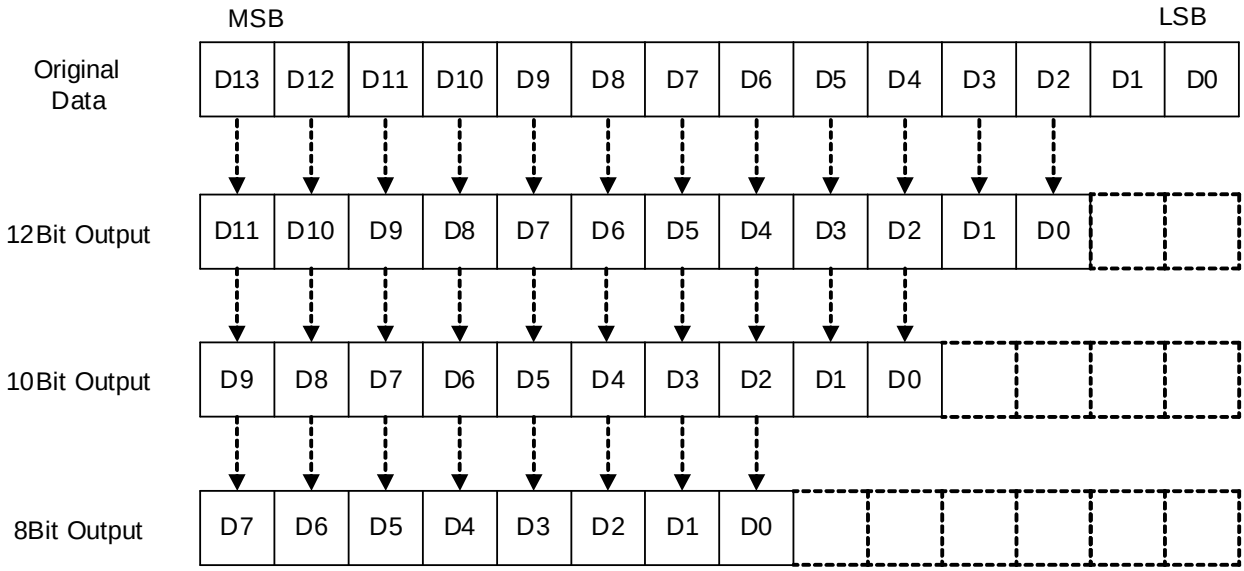


Fig 8.22 Data Format

8.12. Test Image

To check normal operation of camera, it can be set to output test image created inside, instead of image data from CCD. There are 3 types of test image; image with different value in horizontal direction (Test Image 1), image with different value in diagonal direction (Test Image 2), and moving image with different value in diagonal direction (Test Image 3). Test image can be applied in all operation modes of camera and is set using “sti” command.

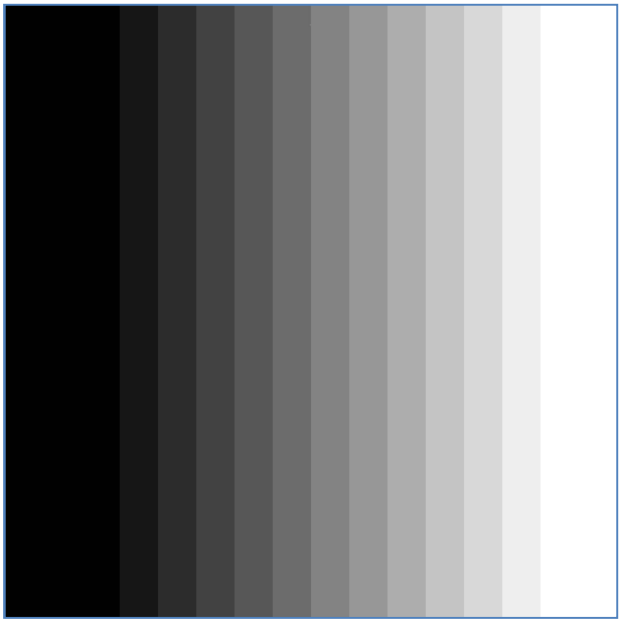


Fig 8.23 Test Image 1

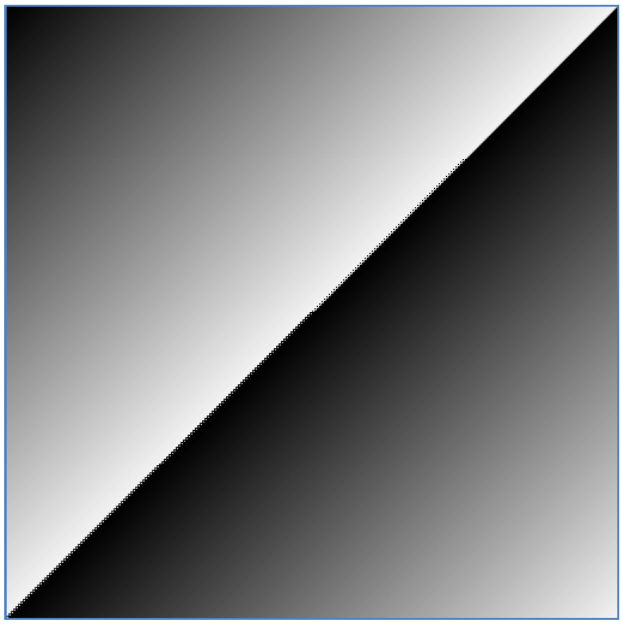


Fig 8.24 Test Image 2

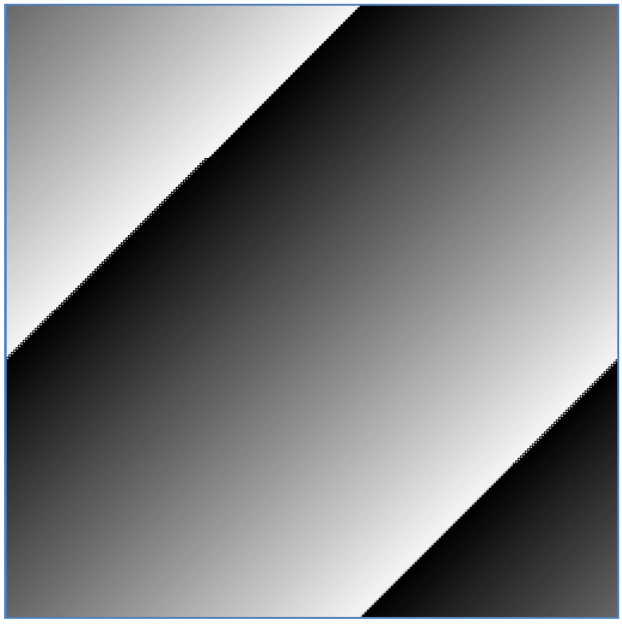


Fig 8.25 Test Image 3

8.13. Horizontal Flip

Function to flip the image right and left based on the central axis of image. This function can be applied to all operation modes and “shf” command is used to set whether to use this function or not.

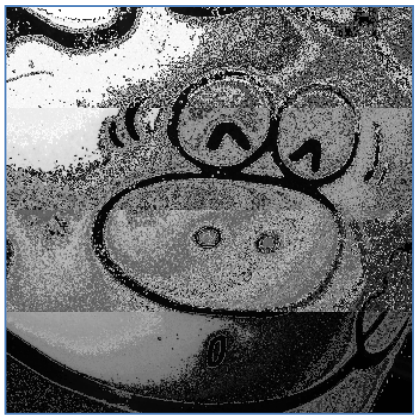


Fig 8.26 Original Image

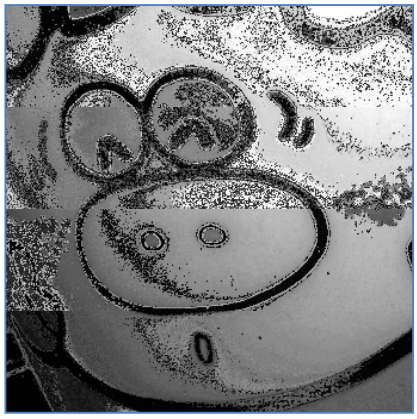


Fig 8.27 Horizontally Flipped Image

8.14. Image Invert(Positive/Negative)

Function to invert the level value of output image. Level value inverted differs depending on output data format even if input value is same. This function can be applied in all operation modes of camera and “sii” command is used to set whether to use this function or not.

Data Format	Original Value	Invertied level Value
8	0	255
10	0	1023
12	0	4095

Table 8.3 Inverted level value by Data Format

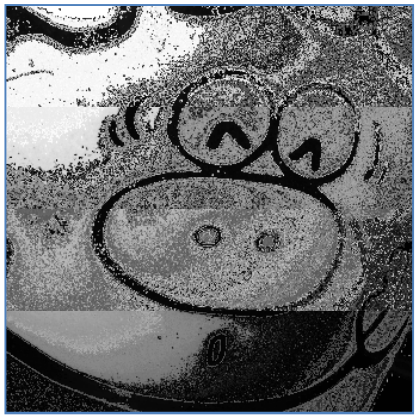


Fig 8.28 Original image (Positive)

Fig 8.29 Inverted image (Negative)

8.15. Strobe

Strobe signal is used to measure the exposure time to synchrnoize the external light source with camera or to measure the exposure time applied to current camera. Pulse width of Strobe signal is from the generating point of Shutter signal to the starting point of Readout, which coincides with exposure time of camera.

8.15.1. Strobe Offset

Strobe Offset value indicates when Strobe signal is to be sent after Shutter signal. Value can be set in the unit of 1us using “sso” command. Only pulse location moves without change in pulse width of Strobe signal.

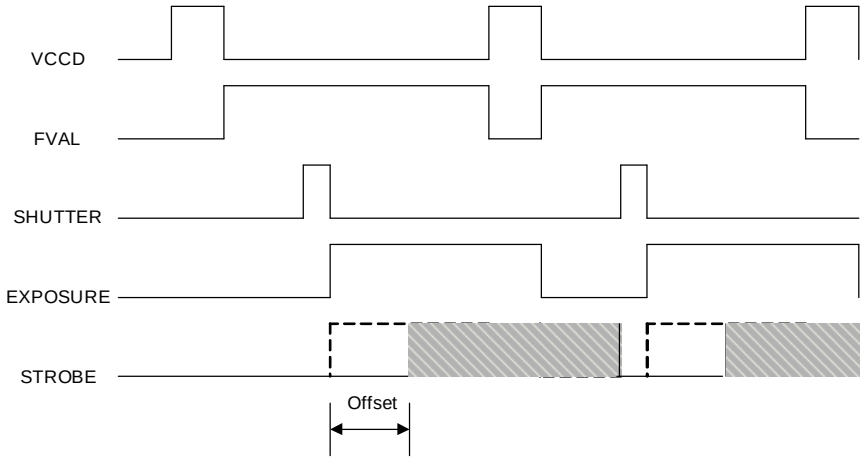


Fig 8.30 Strobe signal in Free-Run

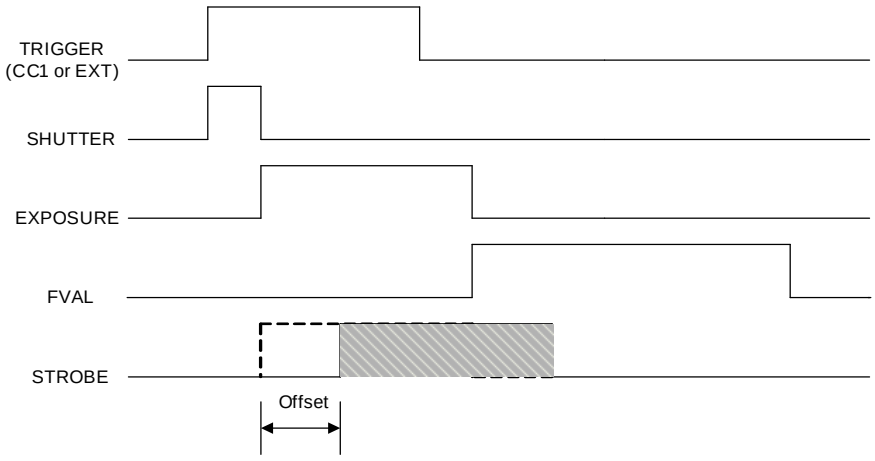


Fig 8.31 Strobe signal in Trigger mode

8.15.2. Strobe Polarity

Polarity can be set for Strobe signal output. “ssp” command is used to set the polarity of Strobe signal.

8.15.3. Field Upgrade

Camera provides the function to upgrade Firmware와 FGPA logic through Camera Link or Gigabit Ethernet interface rather than disassembly in the field. See Appendix C for details on how to change

9. Camera Configuration

9.1. Setup command

All setup in camera is carried out RS-644 serial interface of camera link. With the following communication setting, it can be controlled using terminal or direct control at user application.

- **Baud Rate** : 19200 bps
- **Data Bit** : 8 bit
- **Parity Bit** : No Parity
- **Stop bit** : 1 stop bit
- **Flow control** : None

All types of camera setting commands except Firmware Download, requiring massive data transmission are delivered in ASCII command type. All camera setup commands start from user application and the camera returns the response(“OK”, “Error” or information) for command The camera informs the completion of command execution through response with write command, while the camera returns the error response or information with read command.

Command format:

<command> <parameter1> <parameter2> <\r>

0~2 parameters follow the command.

Response:

- If execution of write command is successfully completed

OK <\r> <\n>

ex) Write command

In response to a “set 100” command the camera will return (in hex value)

Command : 73 65 74 20 31 30 30 0D

set 100<cr>

Response : 73 65 74 20 31 30 30 0D 0A 4F 4B 0D 0A 3E

Set 100<cr><lf> OK<cr><lf> >

Echo result prompt

- If execution of read command is successfully completed

<parameter1> <\r> <\n>

ex) Read command

In response to a "get" command the camera will return (in hex value) Command : 67 65 74 0D get <cr> Response : 67 65 74 0D 0A 31 30 30 0D 0A 3E get<cr><lf> 100<cr><lf> > echo response prompt

- If execution of command is not completed

Error : <Error Code> <\r> <\n>

Prompt:

After sending response, Camera sends prompt always. '>'is used as prompt.

Types of Error Code

0x80000481 : values of parameter not valid

0x80000482 : number of parameter is not matched

0x80000484 : command that does not exist

0x80000486 : no execution right

9.2. Parameter Storage Space

The camera has 3 non-volatile storage space used for parameter storage and 1 volatile work space that is applied to actual camera operation. 3 storage space is divided into Factory Space that contain basic value at the factory, and 2 user space(User Space 1, User Space 2) that can save parameter value temporarily set by the user. User space can be read and written, but Factory space can be read only.

At camera booting, setting value in one of 3 storage spaces is copied to work space according to Config Initialization value and value of the space is used for camera setting. Since values in work space is valid only while the power is on, it should be copied to user space 1 or user space 2 using “sct” command.

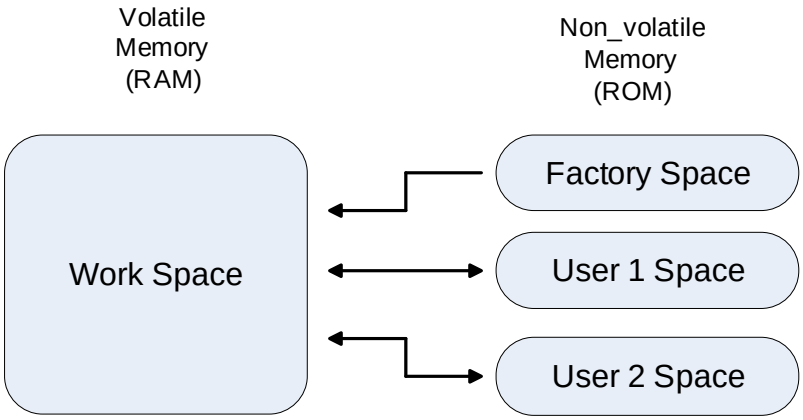


Fig 9.1 Parameter Area

9.3.

Command List

Command	Syntax	Value Returned	Description
Help	h	String	Displays a list of all commands
Set Read-Out Mode **Get Read-Out Mode**	srm 0|1|2 grm	OK 0|1|2	0 : Nomal Mode 1 : AOI(Area Of Interest) Mode (AOI area is set using "sha" and "sva" commands) 2 : Binning(2 or 4) Mode (Binning Factor is set using "sbf" command)
Set Horizontal Area **Get Horizontal Area**	sha n1 n2 gha	OK n1 n2	n1: Starting point of horizontal direction n2 : End point of horizontal direction
Set Vertical Area **Get Vertical Area**	sva n1 n2 gva	OK n1 n2	n1 : Starting point of vertical direction n2 : End point of vertical direction
Set Binning Factor **Get Binning Factor**	sbf 2|4 gti	OK 2|4	2 : 2 by 2 binning 4 : 4 by 4 binning
Set Test Image **Get Test Image**	sti 0|1|2|3 gti	OK 0|1|2|3	0 : Off 1/2 : Fixed Pattern Image 3 : Moving Pattern Image
Set Data Bit **Get Data Bit**	sdb 8|10|12 gdb	OK 8|10|12	8 : 8 Bit Output 10 : 10 Bit Output 12 : 12 Bit Output
Set LUT Select **Get LUT Select**	sls 0|1|2 gls	OK 0|1|2	0 : Off 1 : LUT1 2 : LUT2
Set Flat-Field Correction **Get Flat-Field Correction**	sfc 0|1 gfc	OK 0|1	0 : Off 1 : Active of Flat-Field Correction
Set Defect Correction **Get Defect Correction**	sdc 0|1 gdc	OK 0|1	0 : Off 1 : Active of Defect Correction

Table 9.1 Command List #1

Command	Syntax	Value Returned	Description
Set Image Invert **Get Image Invert**	sii 0|1 gii	OK 0|1	0 : Off 1 : Active of Image Invert
Set Horizontal Flip **Get Horizontal Flip**	shf 0|1 ghf	OK 0|1	0 : Off 1 : Active of Defect Correction
Set Trigger Mode **Get Trigger Mode**	stm 0|1|2|3|4 gtm	OK 0|1|2|3|4	0 : Free-Run Mode 1 : Standard Mode 2 : Fast Mode 3 : Double Mode 4 : Overlap Mode
Set Exposure Source **Get Exposure Source**	ses 0|1 ges	OK 1|2	0 : Program Exposure(by camera) 1 : Pulse Width (by trigger input signal)
Set Trigger Source **Get Trigger Source**	sts 1|2 gts	OK 1|2	1 : CC1 Port Input (Camera Link) 2 : External Input (External control port)
Set Trigger Polarity **Get Trigger Polarity**	stp 0|1 gtp	OK 0|1	0 : Active Low 1 : Active High
Set Exposure Time **Get Exposure Time**	set n get	OK n	n : Exposure Time in us (Setting range : 10 ~ 7,000,000 us)
Set Strobe Offset **Get Strobe Offset**	sso n gso	OK n	n : Strobe Offset Time in us (Setting range : 0 ~ 10,000 us)
Set Strobe Polarity **Get Strobe Polarity**	ssp 0|1 gsp	OK 0|1	0 : Active Low 1 : Active High
Set Analog Gain **Get Analog Gain**	sag n gag	OK n	n :Analog Gain Parameter (Setting Range : 0 ~ 899)
Set Analog Offset **Get Analog Offset**	sao n gao	OK N	n :Analog Gain Parameter (Setting Range : 0 ~ 255)
Set Gain Offset **Get Gain Offset**	sgo 2|3|4 n ggo 2|3|4	OK n	2 : AFE Channel of Right Top Image 3 : AFE Channel of Left Bottom Image 4 : AFE Channel of Right bottom Image n : Analog Gain offset Parameter (Setting Range : -20 ~ +20)
Auto Gain Offset	ago	OK	Auto-Generation Gain Offset

Table 9.2 **Command List #2**

Command	Syntax	Value Returned	Description
Generate Flat Field Data	gfd	OK	Operate Flat Field Generator
Save Flat Field Data	sfd	OK	Save Flat Field Data
Load Flat Field Data	lfd	OK	Load Flat Field Data
Set Flat Field Iteration **Get Flat Field Iteration**	sfi n gfi	OK n	n : (2 ^ n) image acquisitions (Setting Range : 0 ~ 4)
Set Flat Field Offset **Get Flat Field Offset**	sfo n gfo	OK n	n : Flat Field Target Level (Setting Range : 0 ~ 4095)
Set Trigger Polarity **Get Trigger Polarity**	stp 0|1 gtp	OK 0|1	0 : Active High 1 : Active Low

Table 9.3 Command List #3

Command	Syntax	Value Returned	Description
Load Config From	lcf 0|1|2	OK	0 : Load from Factory Setting 1 : Load from User 1 Setting 2 : Load from User 2 Setting
Save Config To	sct 1|2	OK	0 : Save to User 0 Setting(inactive) 1 : Save to User 1 Setting 2 : Save to User 2 Setting
Set Config Initialization **Get Config Initialization**	sci 0|1|2 gci	OK 0|1|2	0 : Load from Factory Setting when initializing 1 : Load from User 1 Setting when initializing 2 : Load from User 2 Setting when initializing
Get Model Number	gmn	String	Displays Camera Model Number
Get MCU Version	gmv	String	Displays MCU Version
Get FPGA Version	gfv	String	Displays FPGA Version
Get Serial Number	gsn	String	Display Serial Number
Get Current Temperature	gct	String	Display Temperature Value

Table 9.4 Command List #4

10. Configurator GUI

10.1. Camera Scan

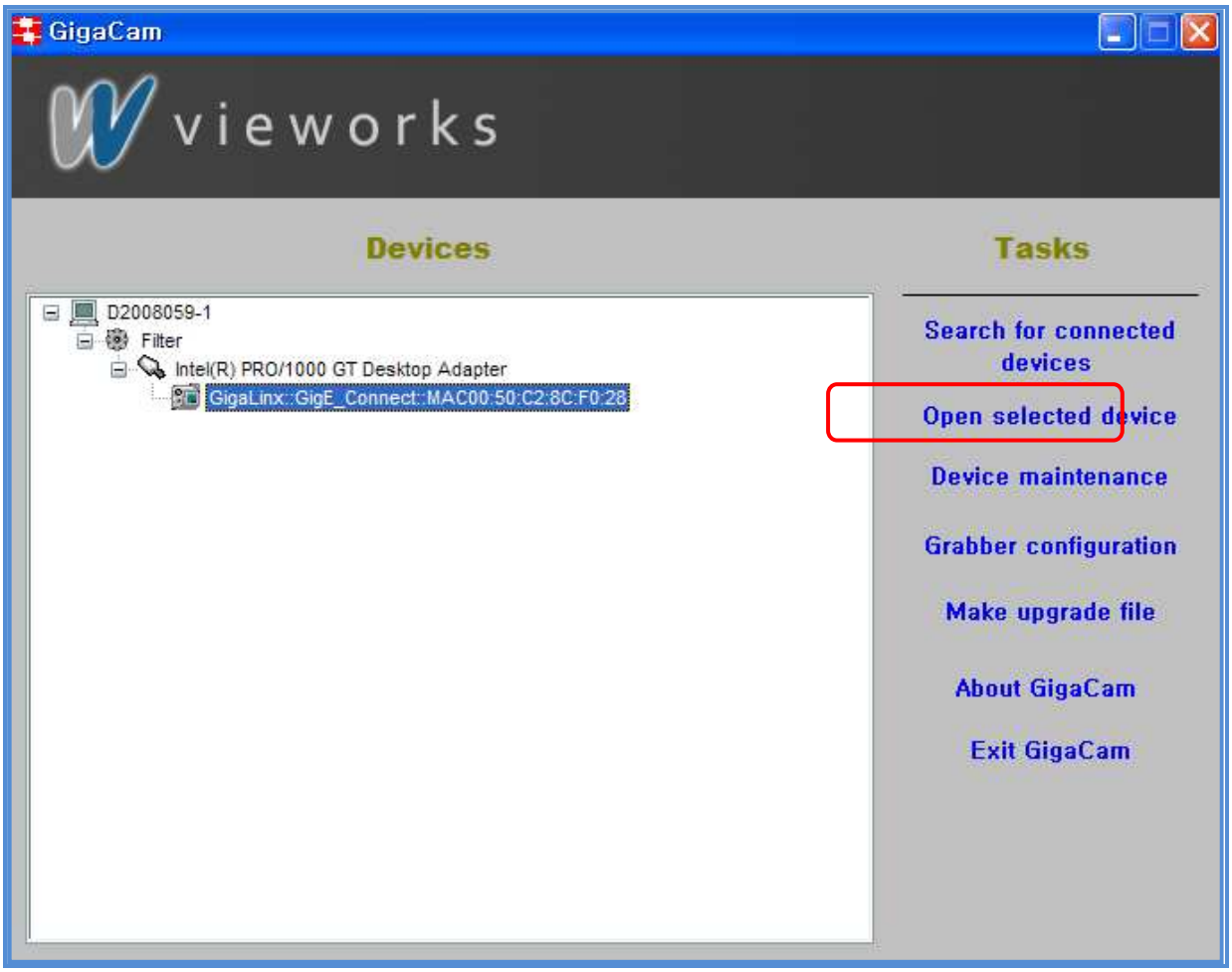
10.1.1. VH-5MC Camera Scan

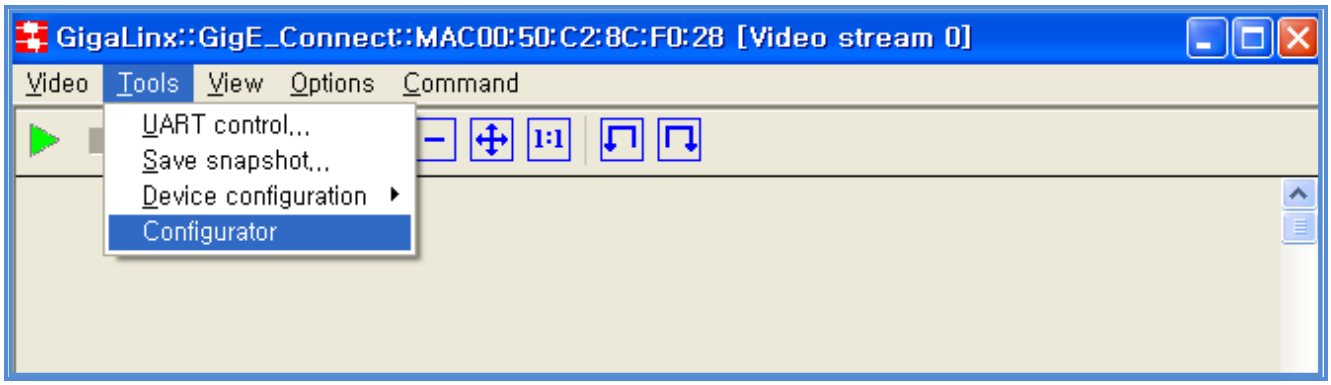
When you execute the program while the camera is turned on, Camera Scan window appears as shown in Fig 10.1. At this time, the program checks serial port of computer and DLL provided by cameralink to scan whether the camera is connected. If there is a camera connected, it displays model name on the screen. If the camera is not properly displayed on the screen, check the connection of cable with power of camera and press refresh button. When you double-click model name displayed on the screen, Configurator is executed and displays current setting value of camera connected.

Fig 10.1 Configurator Loading Window

10.1.2. VH-5MG Camera Scan

Execute GigaCam program while camera is turned on, and execute Open selected device => Tools => Configurator to display Camera Scan window as shown in Fig. 10.2. At this time, the program checks serial port of computer to scan the camera connection, and displays the name of model on the display if there is a camera connected. If the camera is not properly displayed on the screen, check the power of camera and cable connection again, and press Refresh button. Double click the name of model displayed on the screen, to execute Configurator and to display current setting value of camera connected.





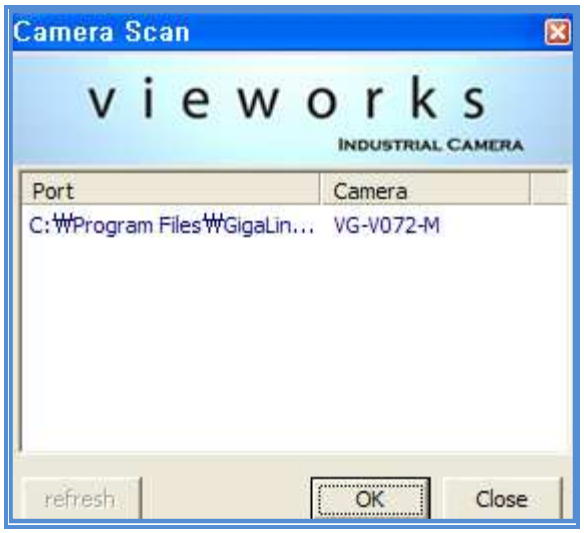


Fig. 10.2 Configurator Loading Window

10.2. Menu

10.2.1. File

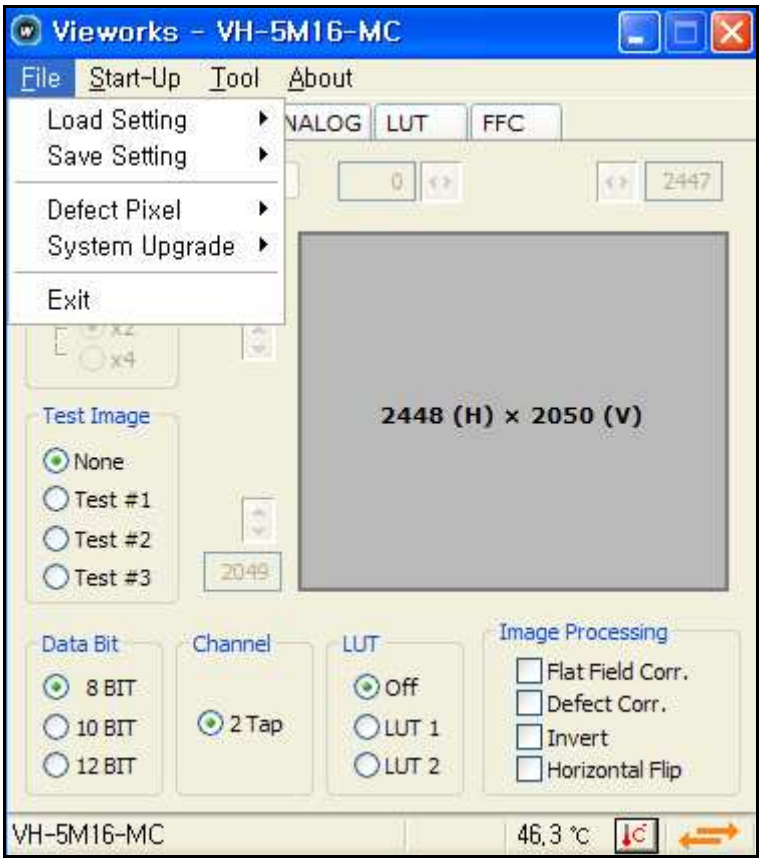


Fig 10.3 File menu

- Load Setting : load setting value of camera, from setting value storage space(Factory, User1, User2) inside the camera or file in the computer.
- Save Setting : save setting value of camera in setting value storage space(User1, User2) inside the camera or file in the user computer.
- Defect Pixel : download Defect information to camera (Download to Camera) or upload the Defect information saved in camera to user computer (Upload to PC).
- System Upgrade : Upgrade MCU program or FPGA logic.
- Exit : Exit the program.

10.2.2. Start-Up

Menu to select the area to load setting value from when camera is turned on.

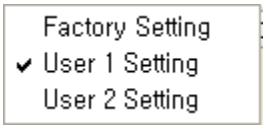


Fig 10.4 Start-Up Menu

- **Factory Setting** : load the setting value from Factory space when camera is turned on.
- **User1 Setting** : load the setting value from User1 space when camera is turned on.
- **User2 Setting** : load the setting value from User2 space when camera is turned on.

10.2.3. Tool

Fig 10.5 Tool Menu

- **Refresh** : load and display the current setting value of camera on the program.
- **Terminal** : display user command under GUI in terminal. Click to display terminal window on the bottom of program. Click again to hide Terminal window.
- **Color calibration** :Bayer Sensor Color calibration.
- **Factory Setting** : Not supported in user.
- **High Speed** : Not supported in VH-5M.

10.2.4. About

Fig 10.6 About Menu

- **Camera Info** : display camera information(product name, serial number, version, etc).

10.3. Tab

10.3.1. VIEW Tab

Tab to control overall function of camera.

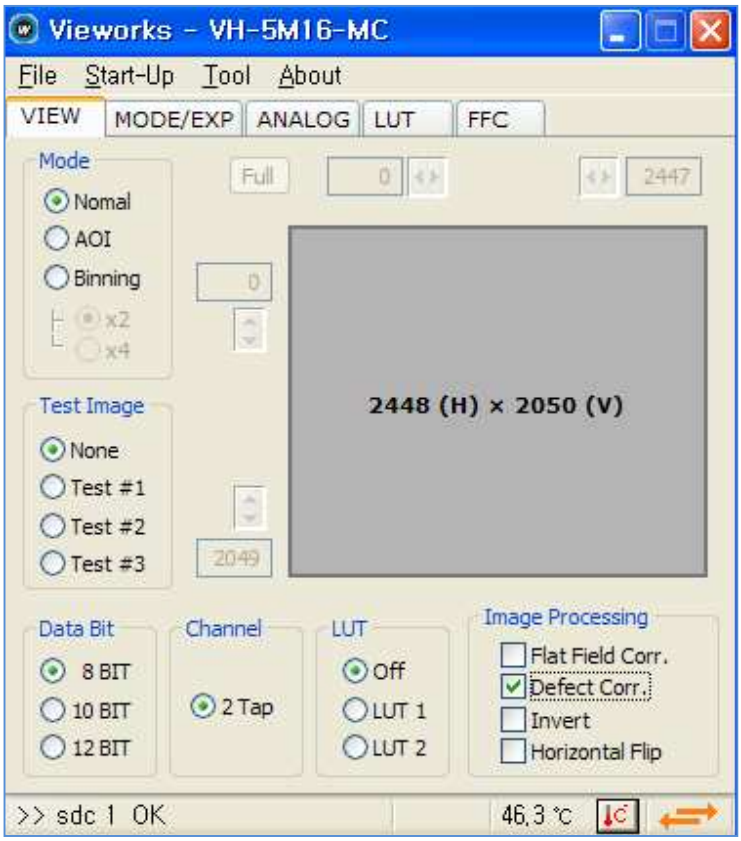


Fig 10.7 VIEW Tab

- **Mode** : select Readout mode. If AOI is selected, right AOI setting area is activated, and AOI can be set with mouse drag or value input. If Binning is selected, x2, x4 selection is activated.
- **Test Image** : select whether to apply test image and type of test image.
- **Data Bit** : set width of data output.
- **Channel** : set channel mode.
- **LUT** : select whether to apply LUT and type of LUT.
- **Imaging Processing** : set On/Off of Defect Correction, Image Invert, Horizontal Flip function (No Flat Field Correction function).

10.3.2. MODE/EXP Tab

Tab to set Trigger mode, exposure time and Strobe. All scroll bars can be adjusted with wheel scroll of mouse.

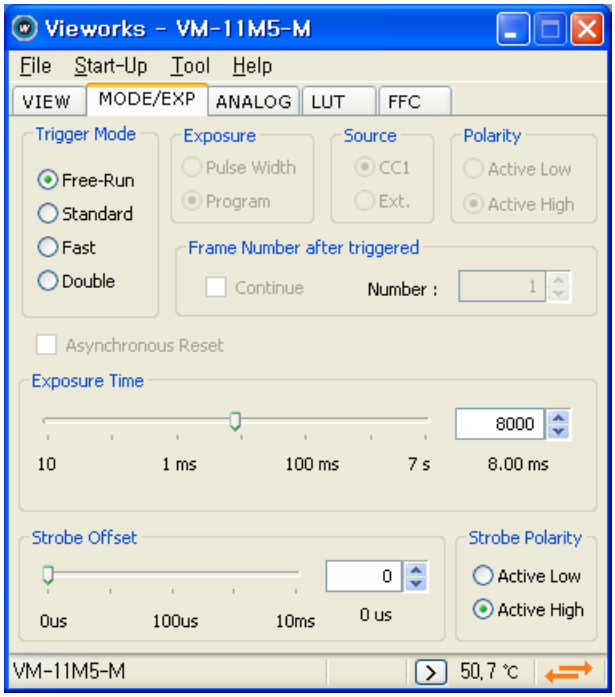


Fig 10.8 MODE/EXP Tab

- **Triger Mode** : set Trigger mode. As this mode is selected, related selection areas are activated.
- **Exposure** : select Exposure source.
- **Source** : select Trigger source.
- **Polarity** : select polarity of Trigger input.
- **Async. Reset** : set Async Reset On/Off.
- **Frame Number ...** : activated in Standard mode. Set the number of frame to receive after trigger.
- **Exposure Time** : set Exposure Time to be applied in Free-Run mode and when Exposure source is set with Program.
- **Strobe Offset** : set Strobe Offset.
- **Strobe Polarity** : set polarity of Strobe output signal.

10.3.3. ANALOG Tab

Tab to set Gain and Offset setting of image. All scroll bars can be adjusted with wheel scroll of mouse.

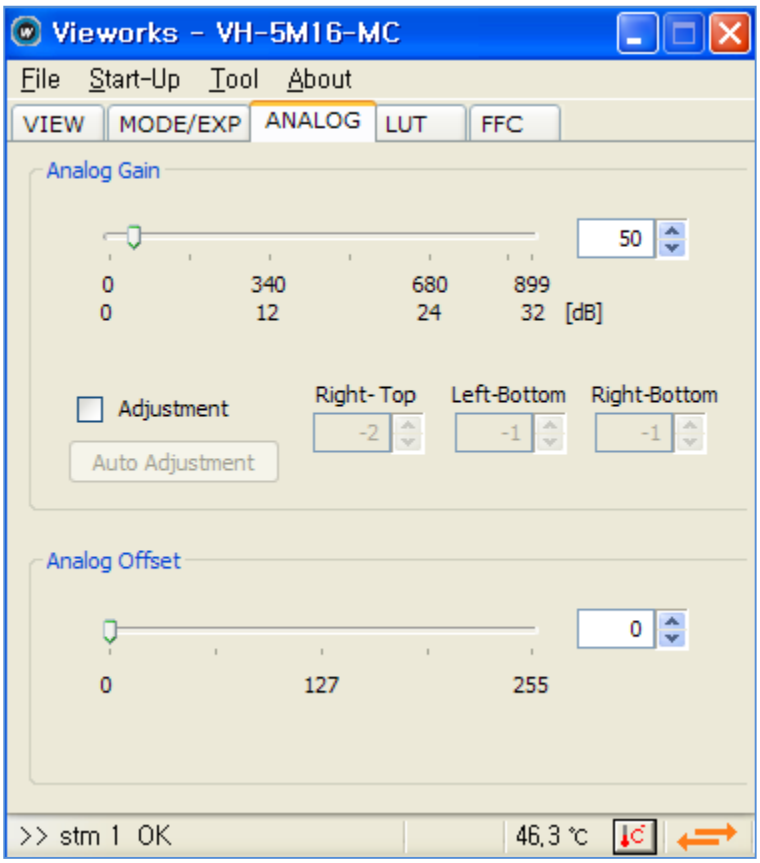


Fig 10.9 ANALOG Tab

- **Analog Gain** : set Gain value of each channel.
- **Analog Offset** : set Offsetvalue of both channels.
- **Adjustment** : Auto Tab balance Adjustment/ Manual Tab balance Adjustment

10.3.4. LUT Tab

Tab to download LUT data. See Appendix B for more details on download.

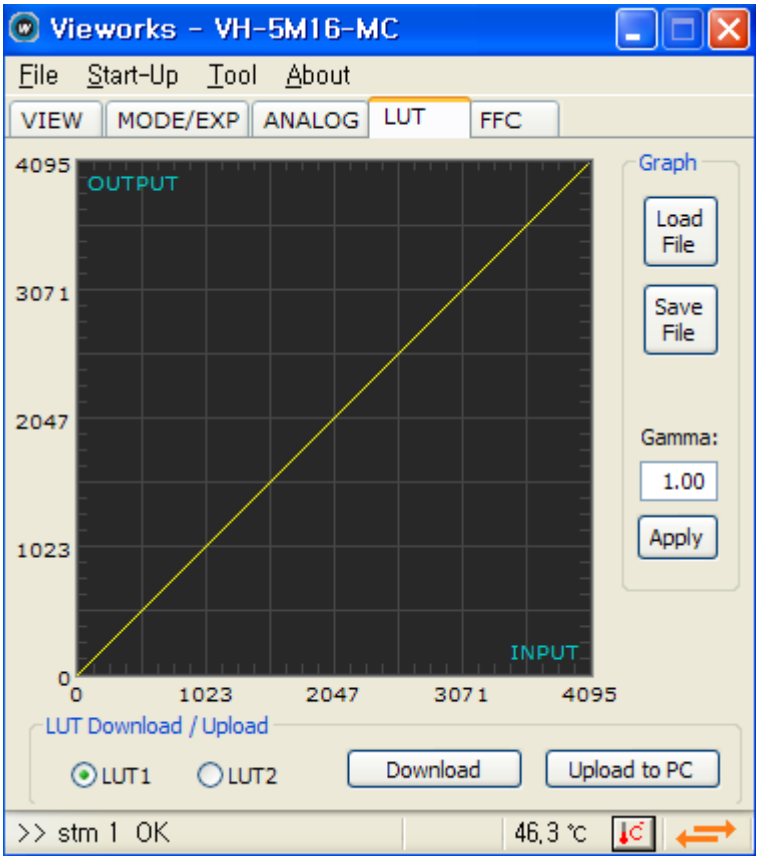


Fig 10.10 LUT Tab

- **Graph**: load LUT data from user file or set Gamma value to be applied when using Gamma curve.
- **LUT Download / Upload**: download LUT data to camera from user computer (Download) or upload LUT data saved in camera to user computer (Upload to PC).

10.3.5. FFC Tab

This tab is used to set Flat Field. All the scrollbars are controllable with the wheel scroll of the mouse.

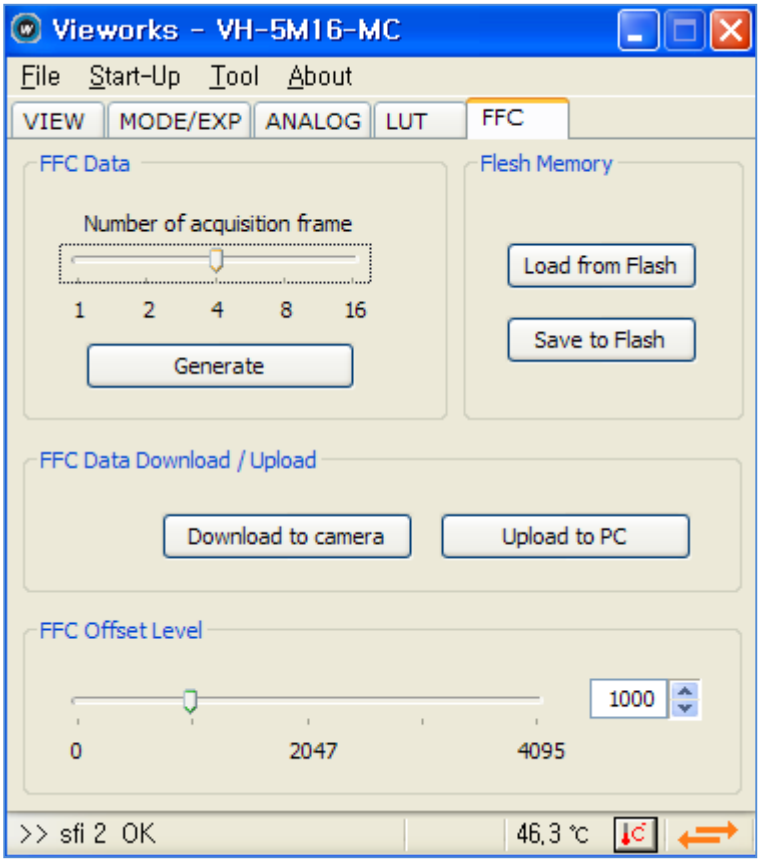


Fig 10.11 FFC Tab

- **FFC data** : Generates the Flat Field data to be used for correction, and sets how many images will be used for the generation.
- **Flash Memory** : In order to reuse the generated FF data in the future, it saves the data onto the Flash or retrieves the saved FF data.
- **FFC Data Downlaod** : Download FFC Data from user's PC to camera, or upload FFC Data from camera to user's PC.
- **FFC offset Level** : Sets the offset value of the image after the Flat Field Correction is applied.

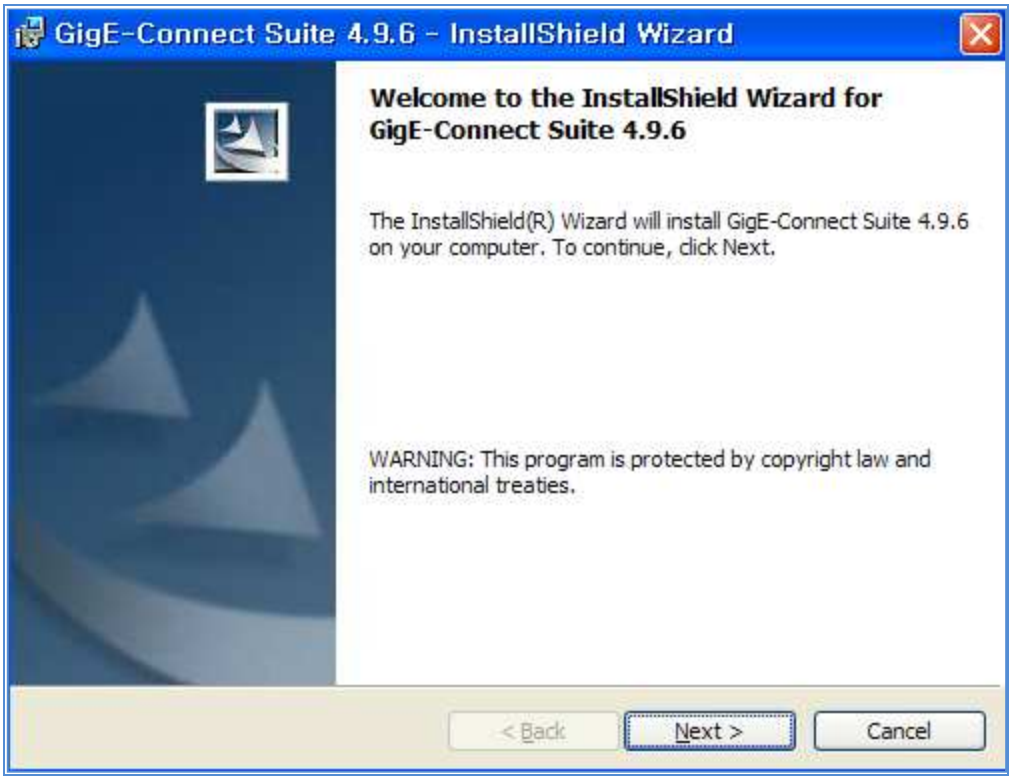
11. GigaCam Installation and Use

GigaCam is the exclusive viewer application for VH GigE interface industrial camera. It is used for control related to image setting and network environment setting.

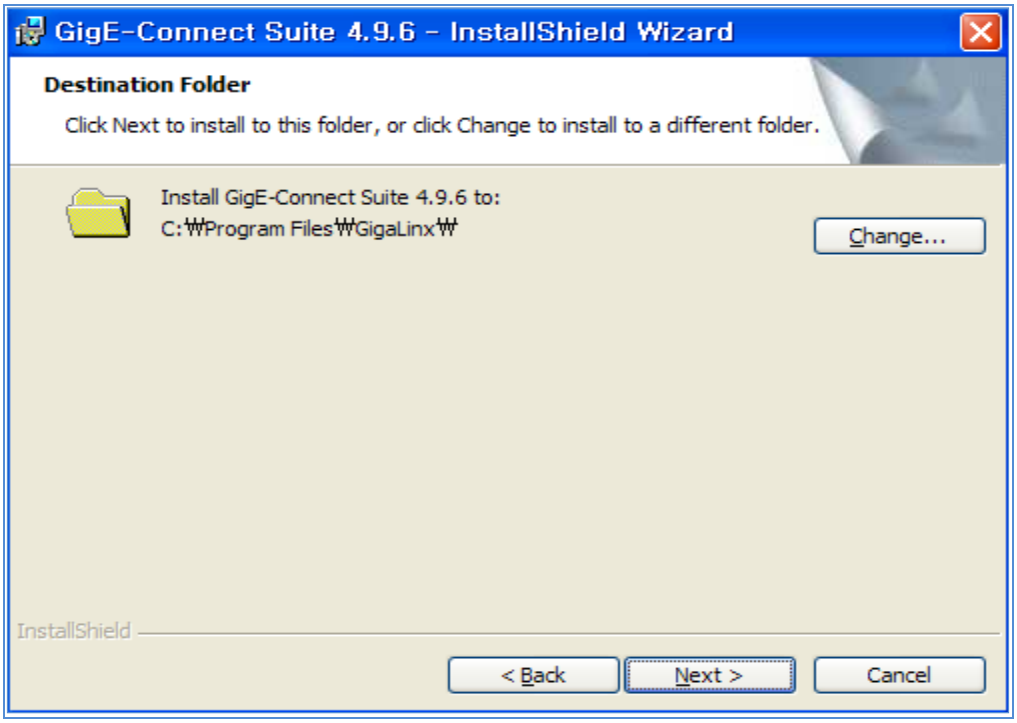
11.1. GigaCam Installation Method

11.1.1. Execute Install File

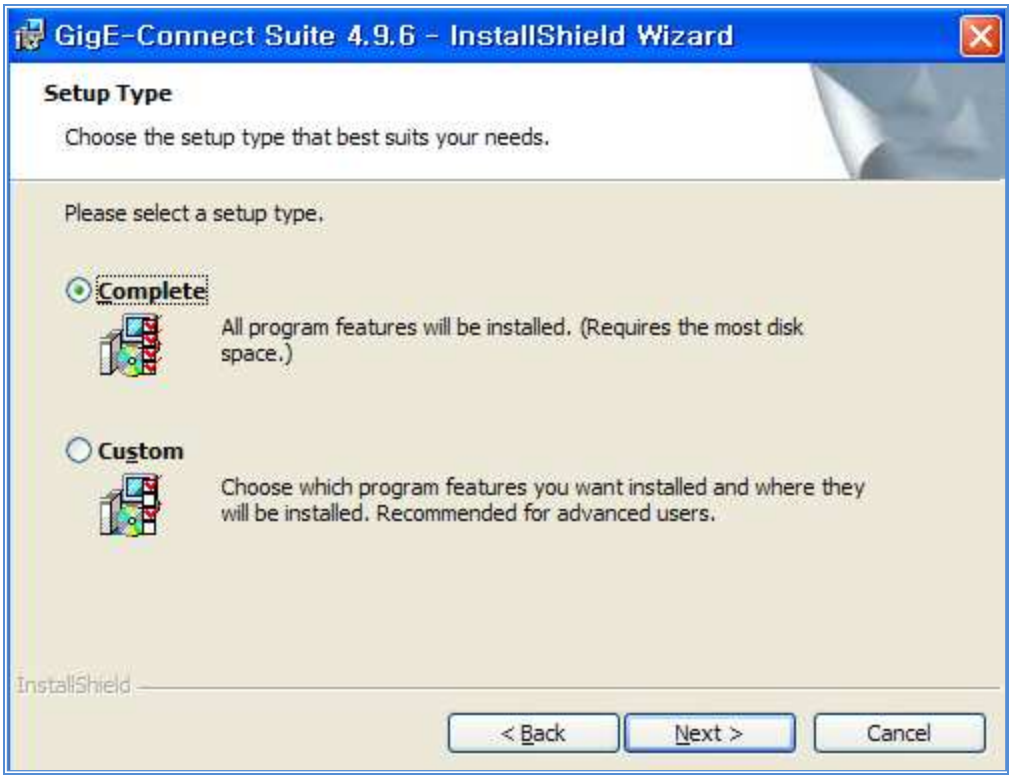
11.1.2. Continue InstallShield Wizard



11.1.3. Designate Install Directory

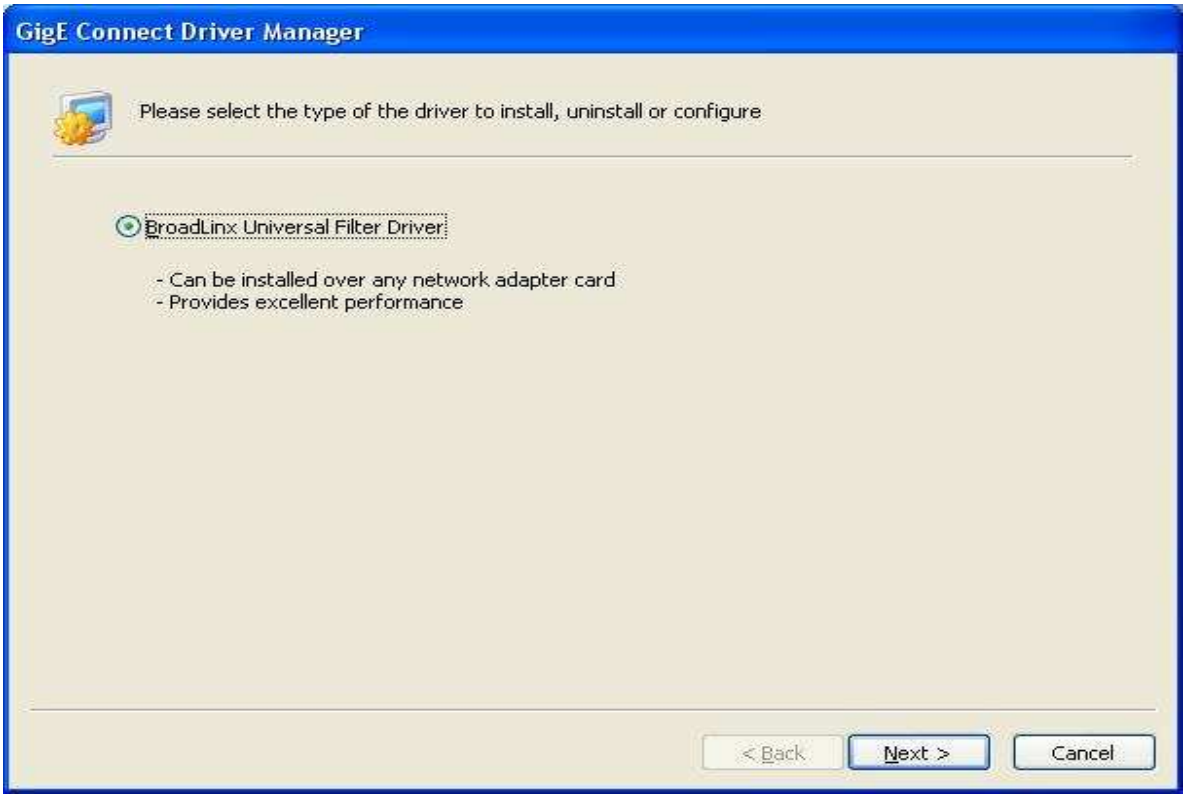


11.1.4. Select Setup Type (Recommended: Complete)

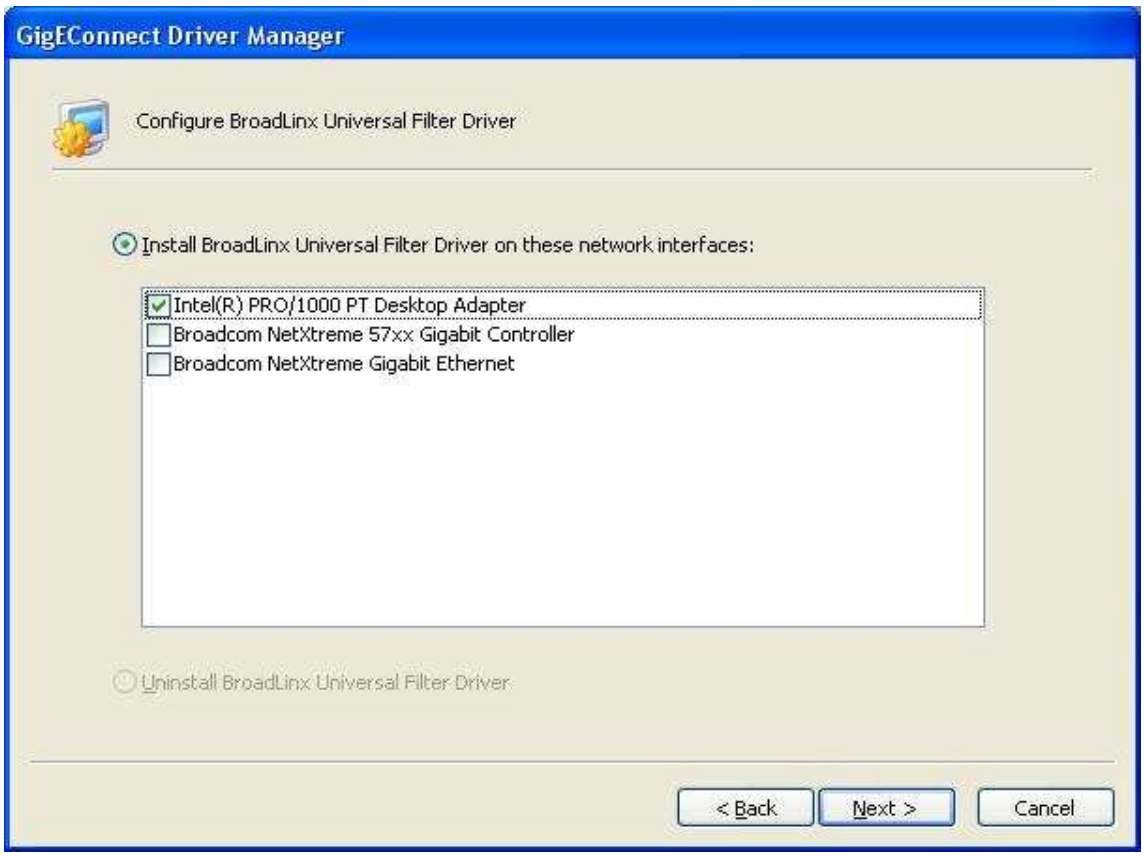


11.1.5. Designate GeniCam Root Path(Click Next)

11.1.6. Select BroadLinx Universal Filter Driver

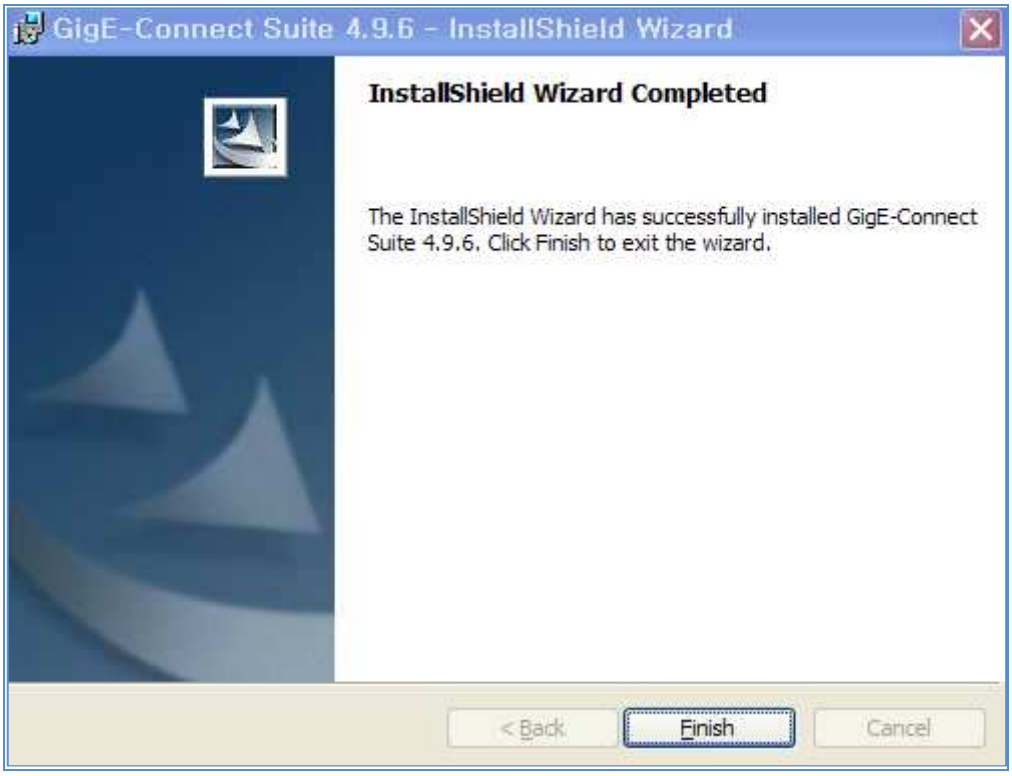


11.1.7. Select the target to install BroadLinx Universal Filter Driver

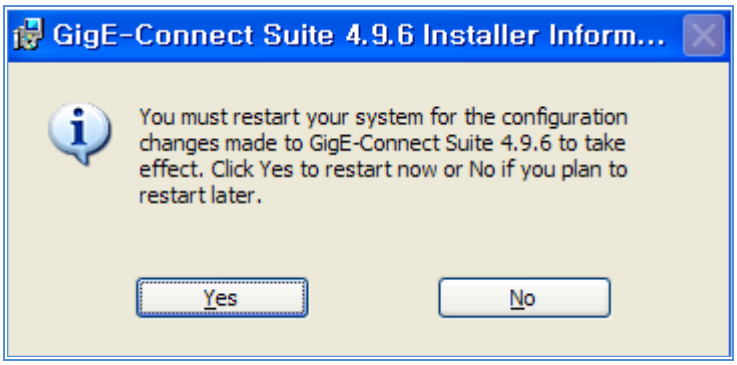


11.1.8. Select Continue if warning popup appears during installation

11.1.9. Finish installation



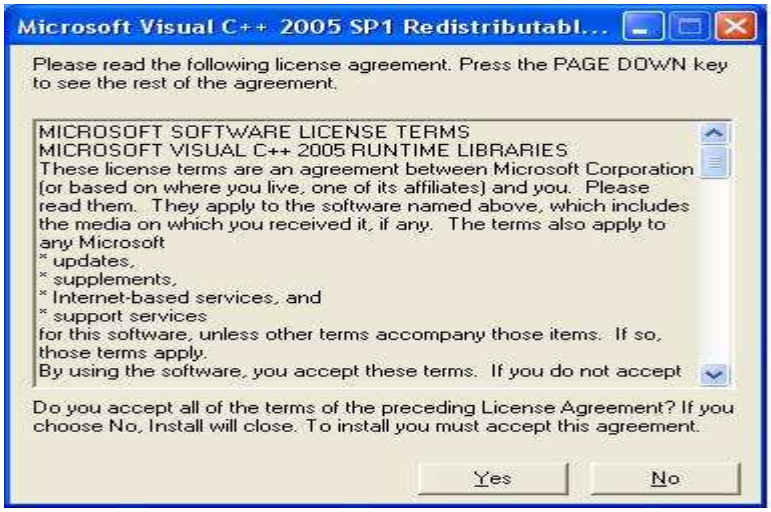
11.1.10. Restart the system



11.1.11. Install VS2005 Redistribution Package

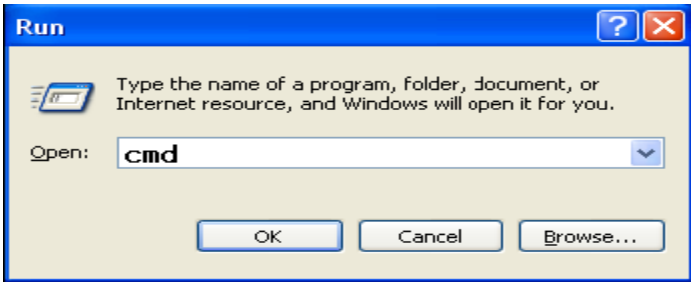
11.1.11.1. Execute "scredist_x86.exe"

11.1.11.2. Click Yes (Completed)

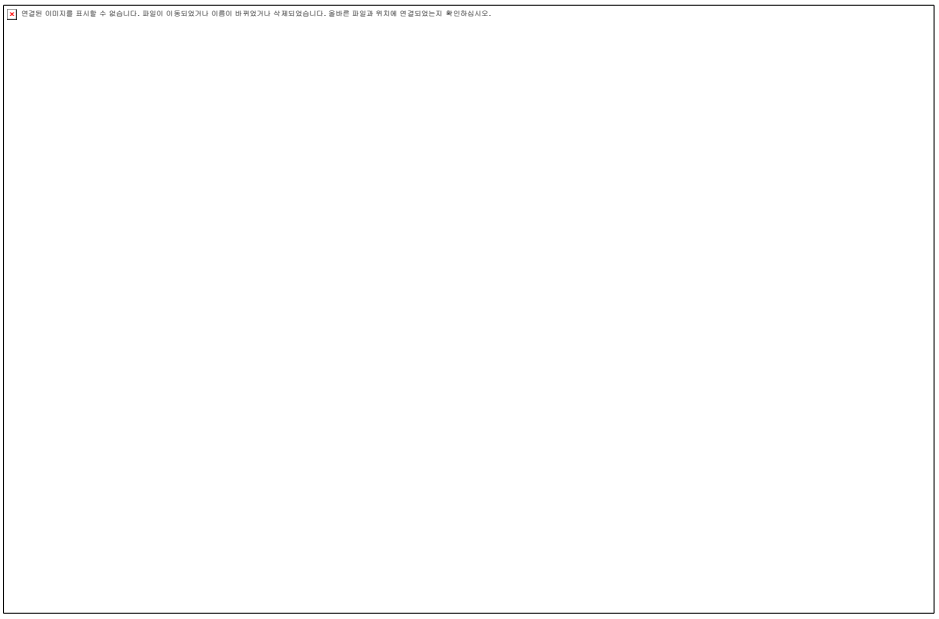


11.1.11.3. If Syntax error occurs

- Save “vcredist_x86.exe” file in C:\ directory
- Open Windows Command window



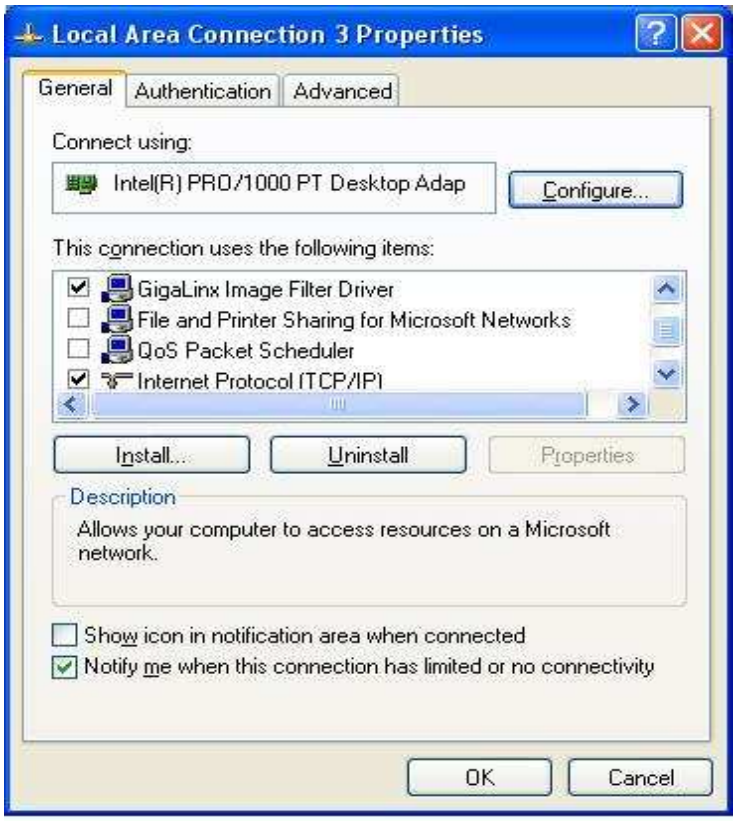
- Execute “vcredist_x86.ext” in C:\



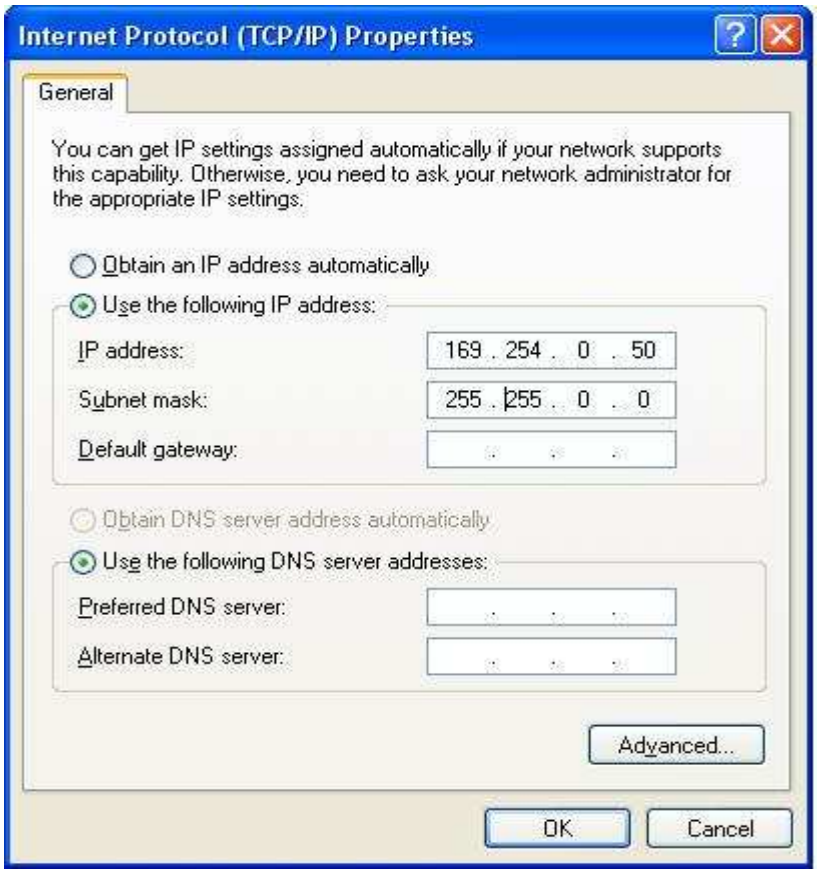
11.2. Network Environment Setting

11.2.1. Change Network Connection Property

- Uncheck except GigaLinx Image Filter Driver, internet protocol (TCP/IP)



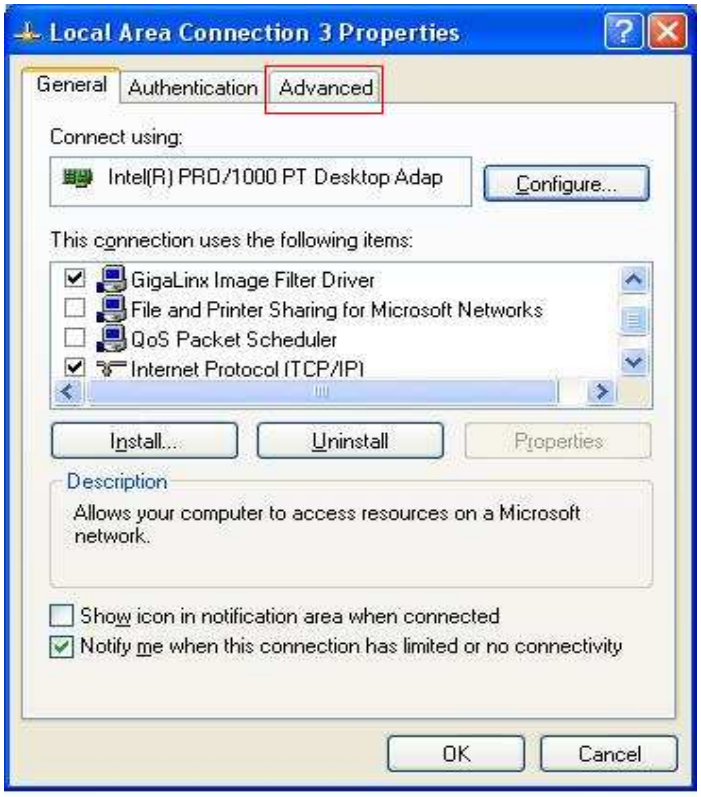
11.2.2. Confirm after Changing Internet Protocol(TCP/IP) Property



- **IP Address : 169.254.X.Y (X = 0 ~ 255, Y = 50 ~ 255)**
- Subnet Mask : 255.255.0.0

11.2.3. Disable Firewall

11.2.3.1. Click Advanced Tab

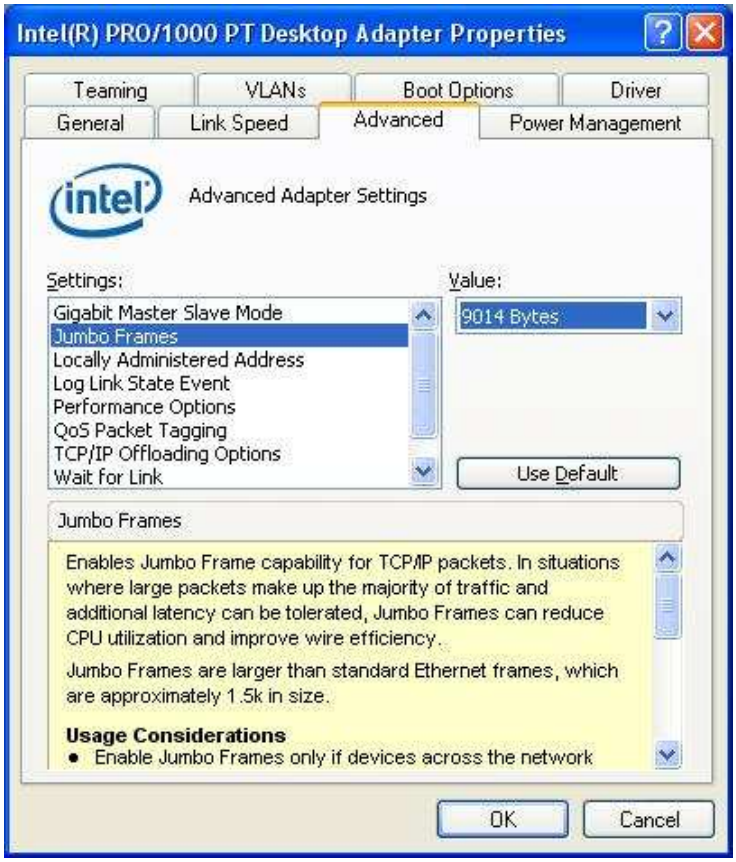


11.2.3.2. Click Settings

11.2.3.3. Click off(not recommended)

11.2.4. Configure NIC Driver (Click Configure)

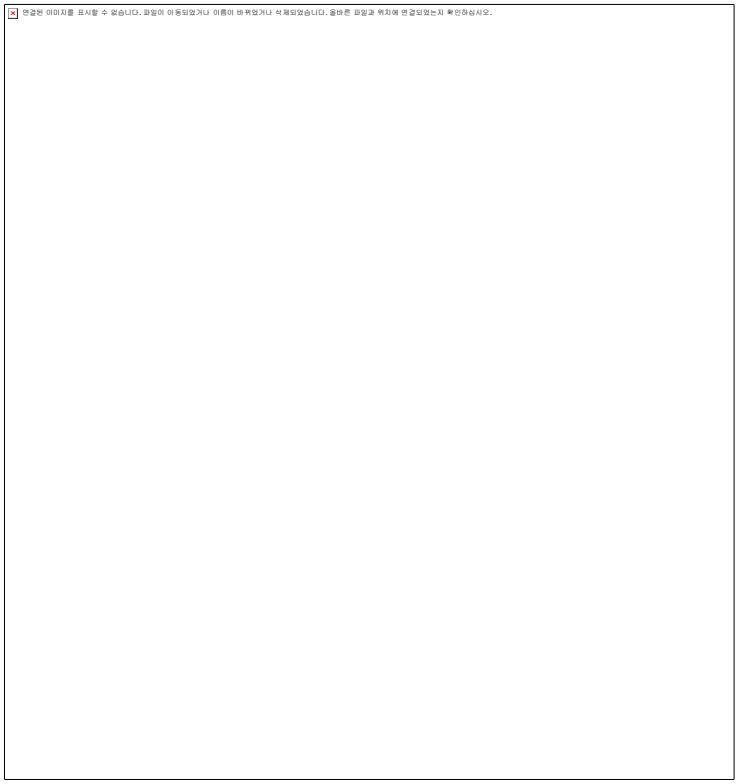
11.2.4.1. Set Jumbo Frame



Select Advanced -> Jumbo frame -> Value : 9014 Bytes

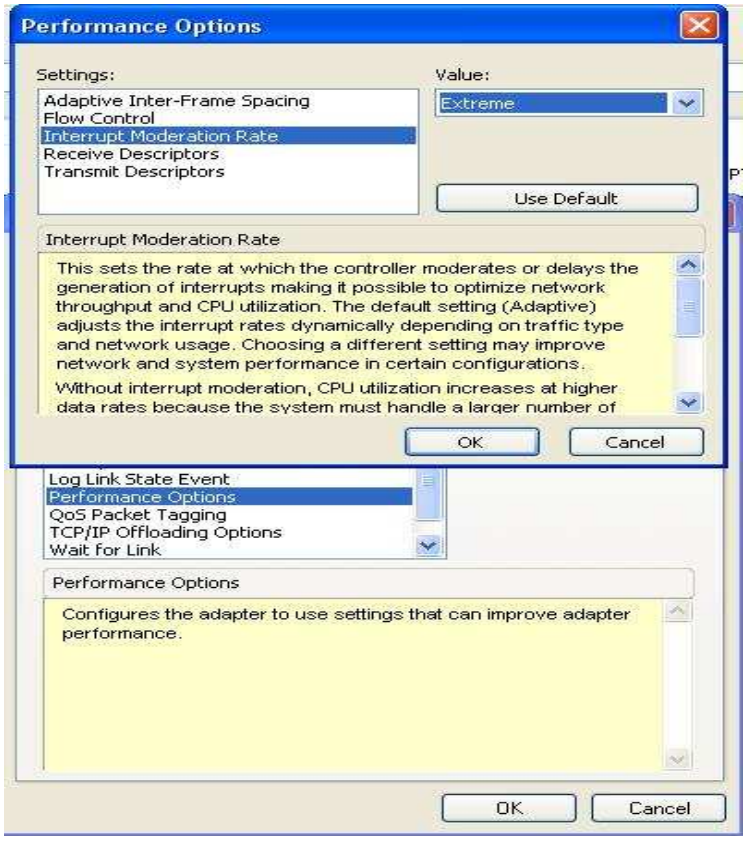
(※Maximum value differs depending on model of network card)

11.2.4.2. Set Performance Option

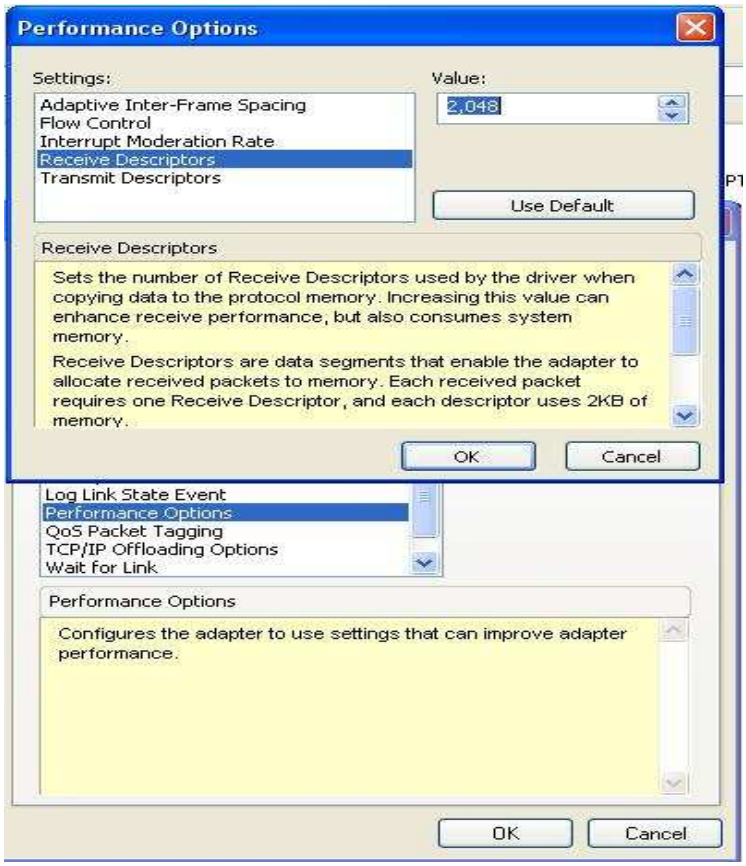


Advanced -> Performance Option -> Registration Information

11.2.4.3. Set Interrupt Moderation Rate at Extreme

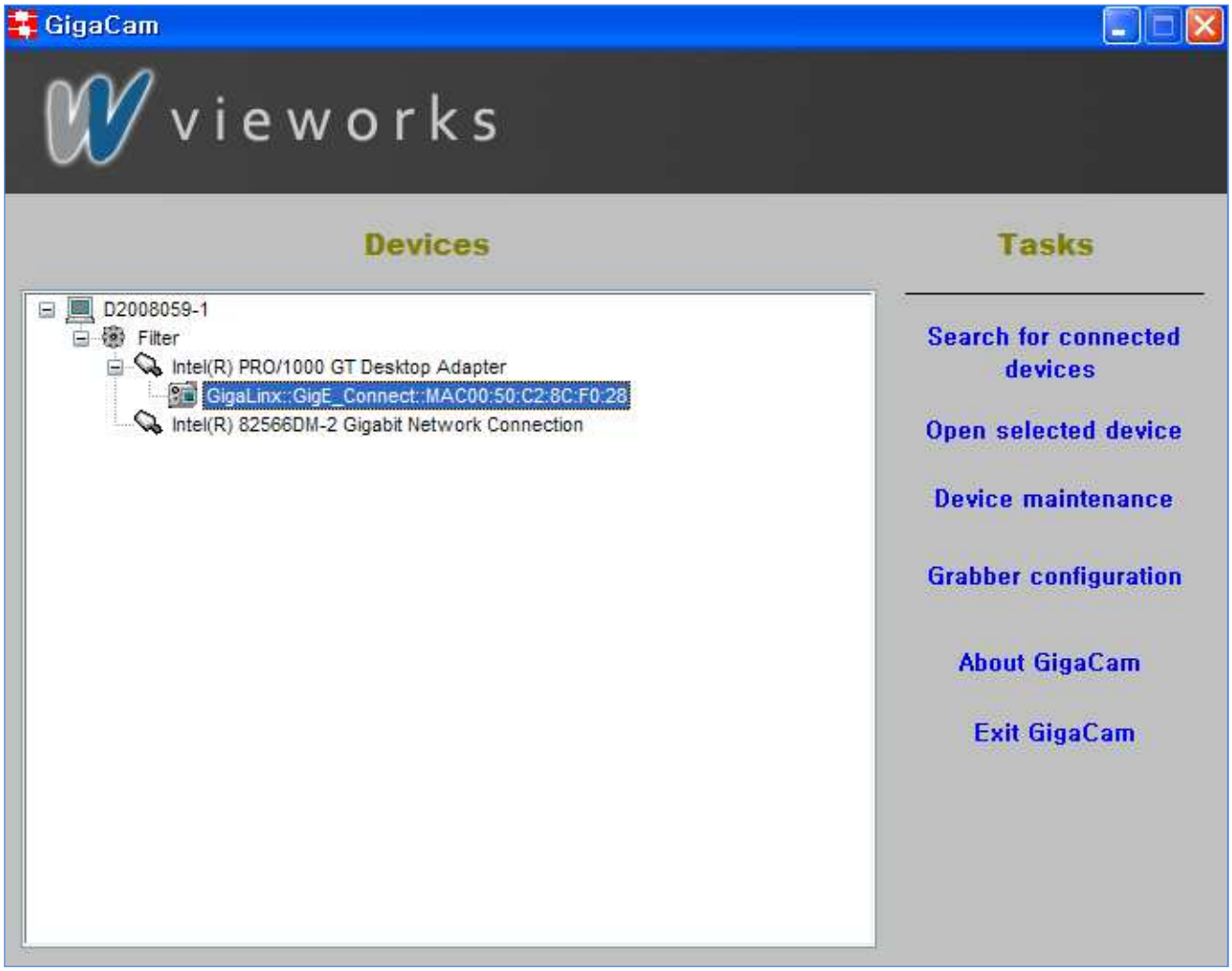


11.2.4.4. Set Receive Descriptors at 2,048



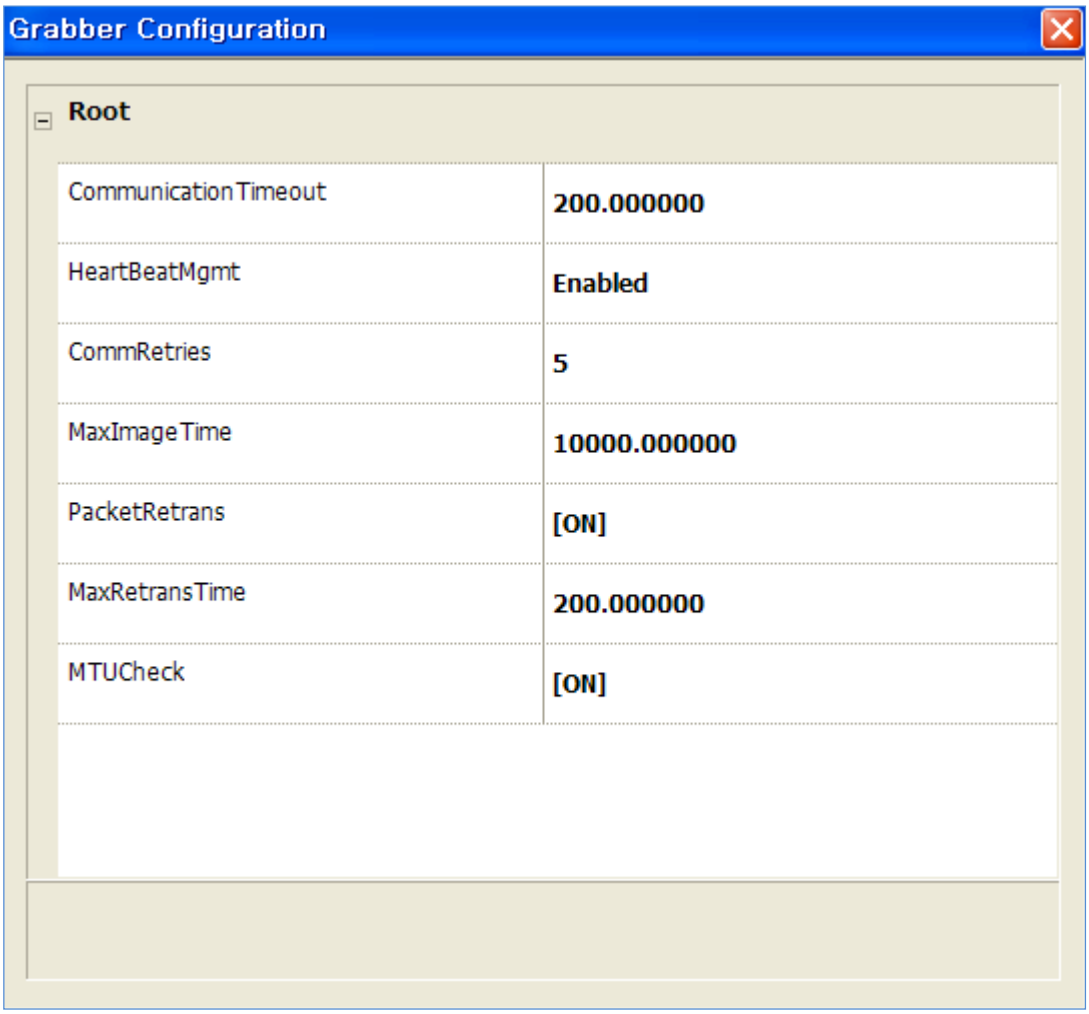
11.3. GigaCam Use

11.3.1. Execute GigaCam Program



- **Search for connected devices** : search for camera connected.
- **Open selected device** : execute camera selected.
- **Device maintenance** : used for updating configuration file.
- **Grabber configuration** : used for changing Grabber configuration.
- **About GigaCam** : check GigaCam version information
- **Exit GigaCam** : exit GigaCam program

11.3.2. Grabber configuration



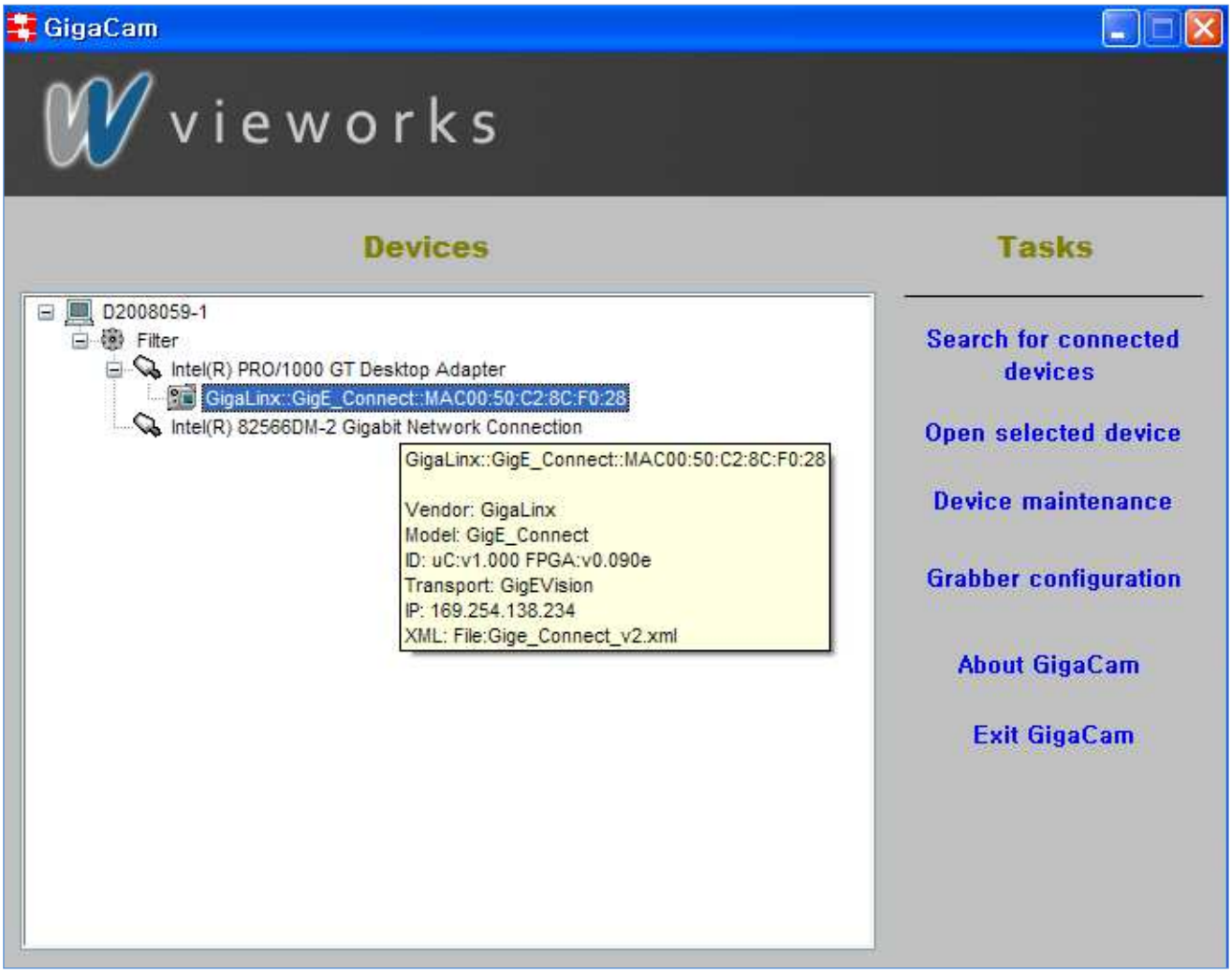
- Communication Timeout : set time for communication Timeout (unit: ms)
- HeartBeatMgmt : set HeartBeat Management (Enabled / Disabled)
- CommRetries : set communication retries (number)
- MaxImage Time : set time for receiving Image data (unit: ms)
- PacketRetrans : set whether to retransmit in case of Packet loss (ON/OFF)
- MaxRetransTime : set retransmission time (unit ms)
- MTUcheck : set Network MTU check (ON/OFF)

Caution) Setting value of Grabber Configuration should be changed depending on HeartBeatTimeout setting value.

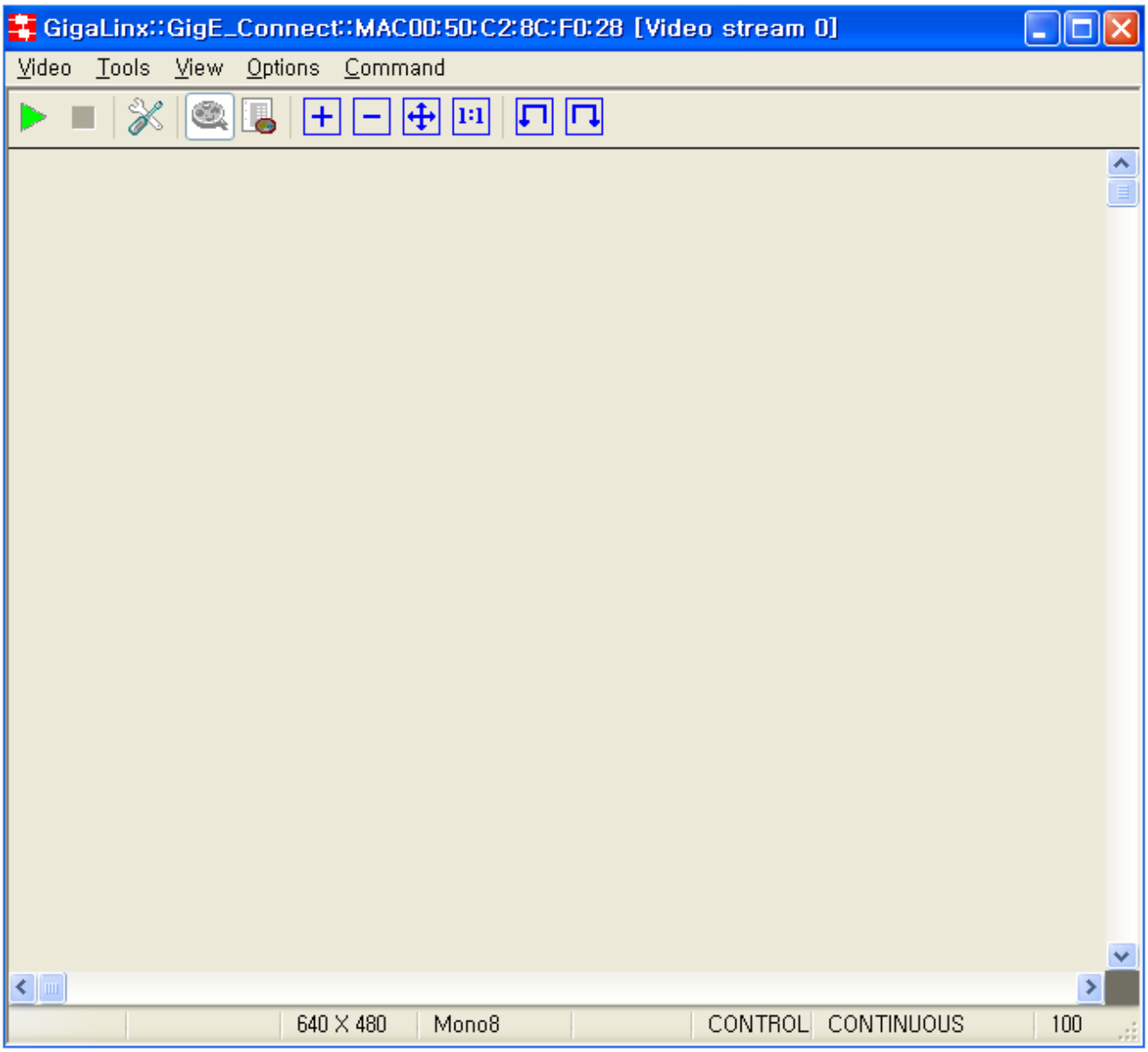
Ex. If HeartBeatTimeout = 1000 (ms), Communication Timeout = 100 (ms)

CommRetries = 5 (times)

11.3.3. Select Camera Connected, and Click Open Selected Device



11.3.4. Open Video Streaming Window



11.3.4.1. Video

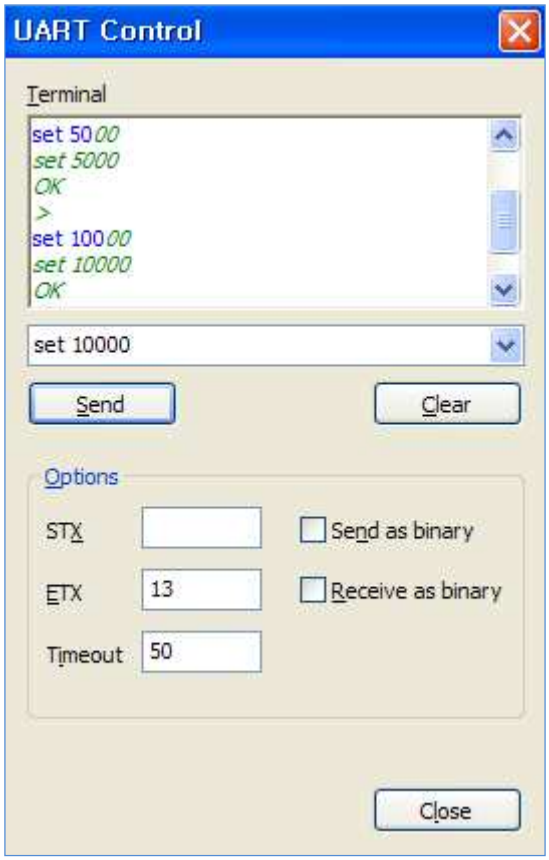
- Play : play image 

- Stop : stop image 

- Open video stream: not used

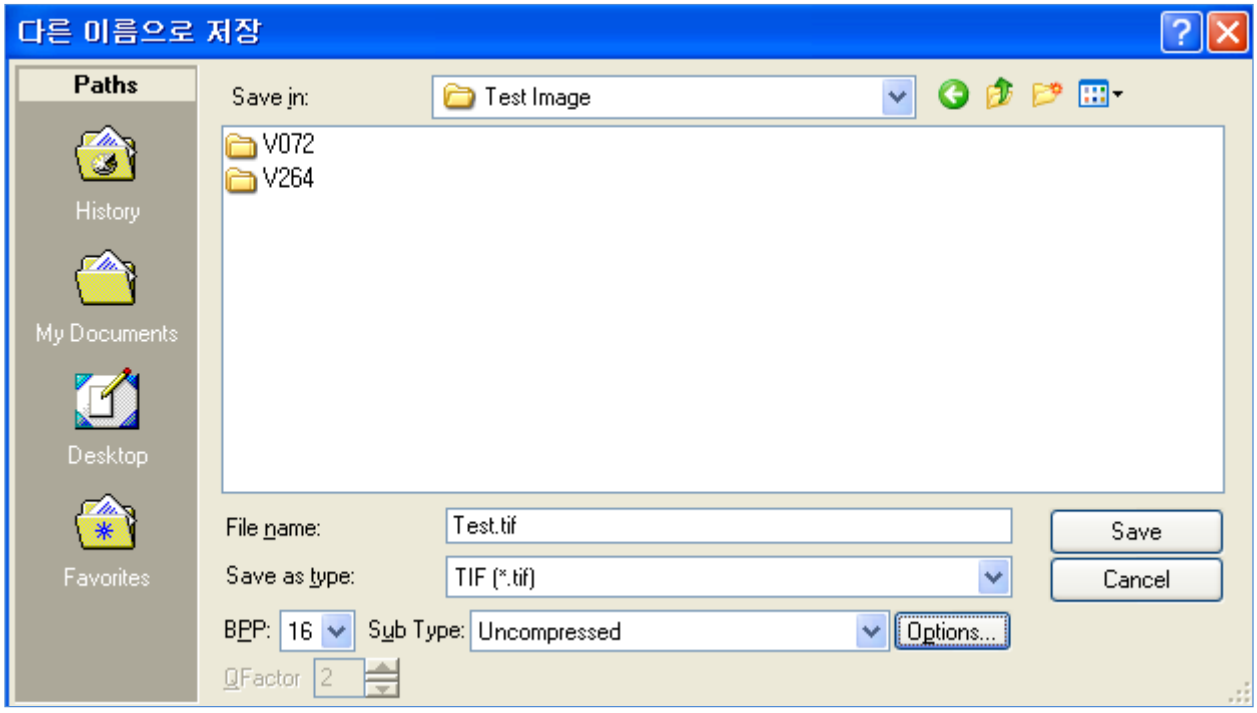
11.3.4.2. Tools

- UART control : can change all settings of camera to command form through Serial interface



Ex) set 10000 : change exposure time to 10ms

- Save snapshot : Image capture function



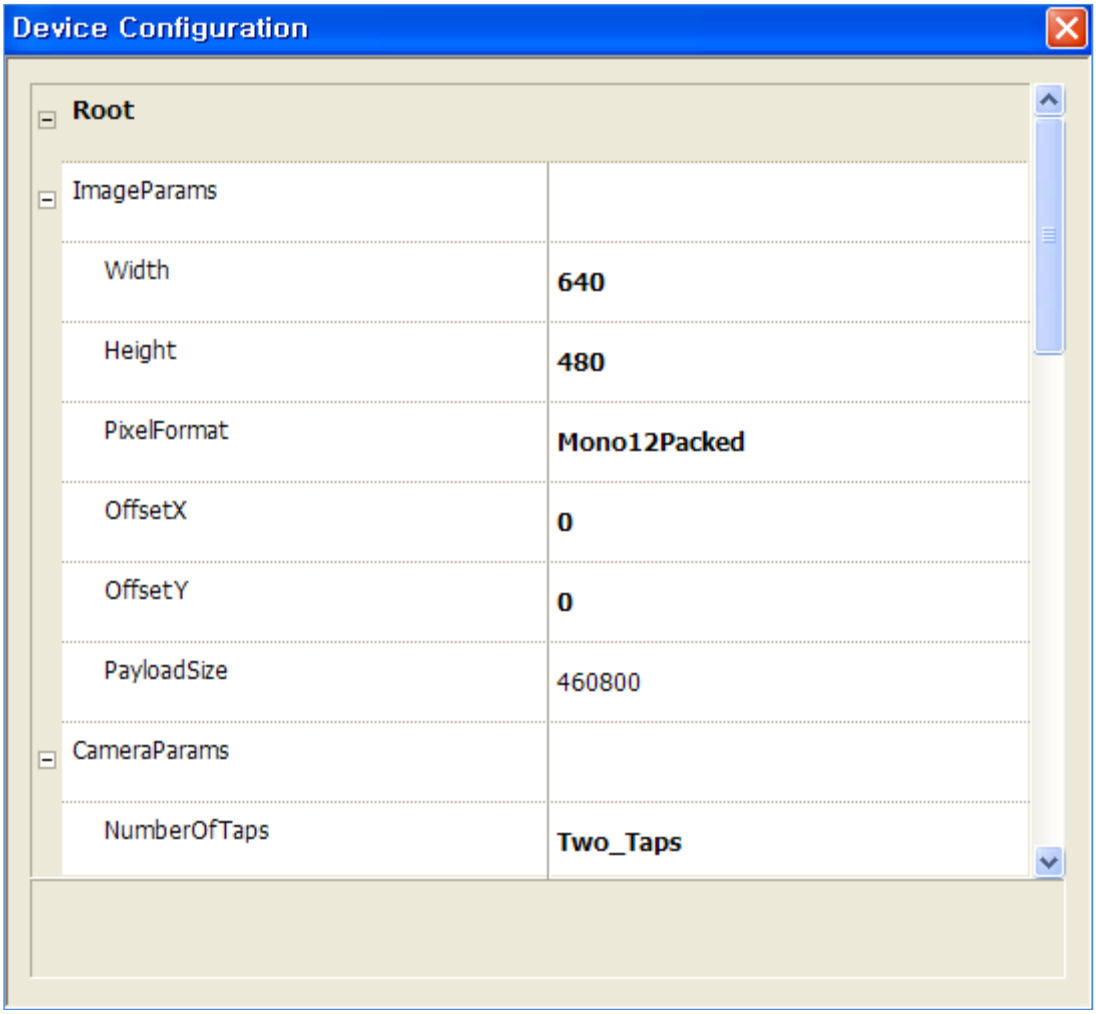
- Device configuration -> Export : save as Device configuration environment setting file (*.dcf)

-> Import : get Device configuration environment setting (*.dcf)

- Configurator : execute Camera Control program

11.3.4.3. View

- Device Parameters 



- Width : Image columns (Horizontal Pixels)
- Height : Image Rows (Vertical Pixels)
- PixelFormat : Data Output (ex. Mono8, mono12Packed)
- OffsetX : X offset setting if ROI used
- OffsetY : Y offset setting if ROI used
- PayloadSize : packet image size (Read only)
- NumberOfTaps : channel mode setting (ex. One_Tap, Two_Taps)
- LineAreaCamera : select CCD scan type
- GevSCPS_PacketSize : set Image Packet size (set to fit maximum value of NIC jumbo frame)

(ex. Intel PRO/1000 GT model : jumbo frame (16128Byte) => can be set to maximum(15000))

- InterPacketDelay : Delay setting between Image packet
- BandwidthMBps : Video Bandwidth setting
- DHCPEnabled : automatically assign IP through DHCP server
- PersistentIP : can set Static IP
- IP_PersistentIPaddress : Static IP setting
- IP_PersistentIPsubnet : Subnet Mask setting
- PixelFrequency : Not supported
- UARTbitrate : UARTbitrate setting (use 19200bps)
- HeartbeatMode : network communication ACK function
- HeartbeatTimeout : Device Reset if there is no HeartbeatResponse in setting value
  (ex. 3000 => Device Reset if there is no Heartbeat Response in 3 seconds
- IgnoreDVAL : ignore DVAL (Enable)
- AcquisitionMode : obtain Image Frame (ex. Continuous : obtain image continuously)
- AccessMode
- ProgramEnable : select whether to save in Parameter setting value in non-volatile memory
- SaveParameters : Save in non-volatile memory

※ **Save Parameter setting value in non-volatile memory:**
ProgramEnable => Set as Enable, SaveParameters => Execute

- Video : if not checked, image is not displayed.

- Statistics  : display information related to Image capture.

- Zoom -> Zoom in  : expand Image

-> Zoom out  : reduce Image

-> Fit to window  : adjust the size of image to fit Window

-> Actual Pixels  : adjust the image to fit actual size

- Rotate -> Left 90°  : rotate Image 90°to the left

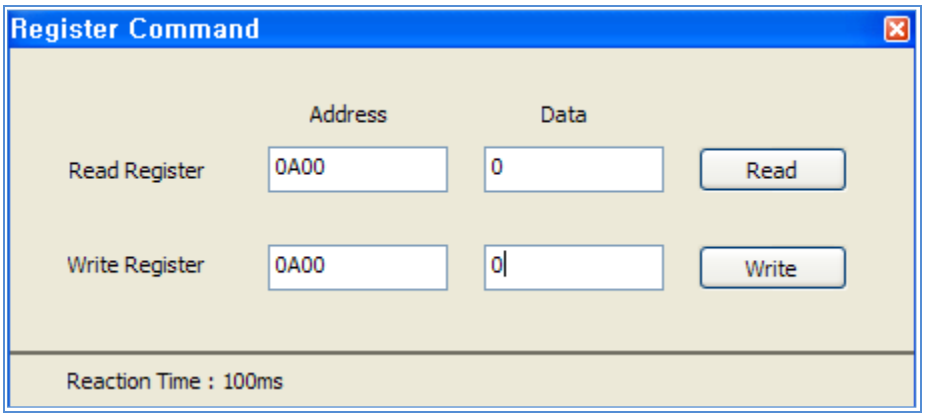
-> Right 90°  : rotate Image 90°to the right

11.3.4.4. Options

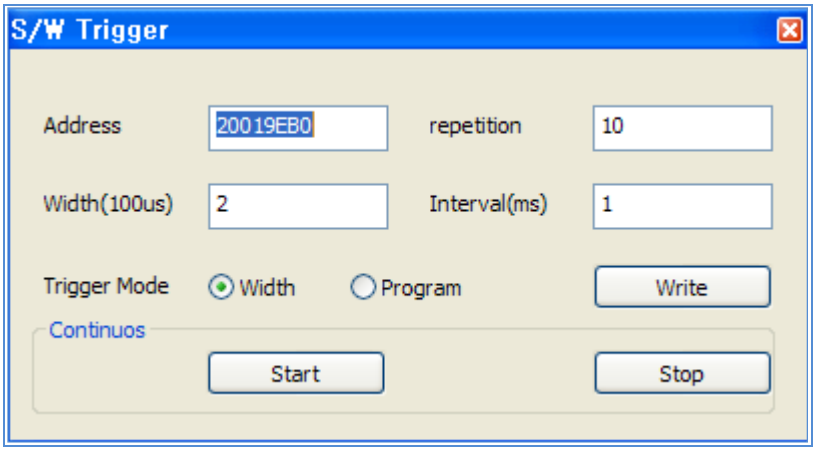
- Image timeout : close acquisition port and display when the image is not acquired for the time set.
- Buffer size : set the Image buffer size of GigaCam application.
- Multicast address
- Max. display FPS : set maximum framerate displayed on the screen

11.3.4.5. Command

- Register : directly access to Gigabit FPGA Register



- Trigger : generate S/W Trigger signal.



12. Mechanical Spec

12.1. External Dimensions

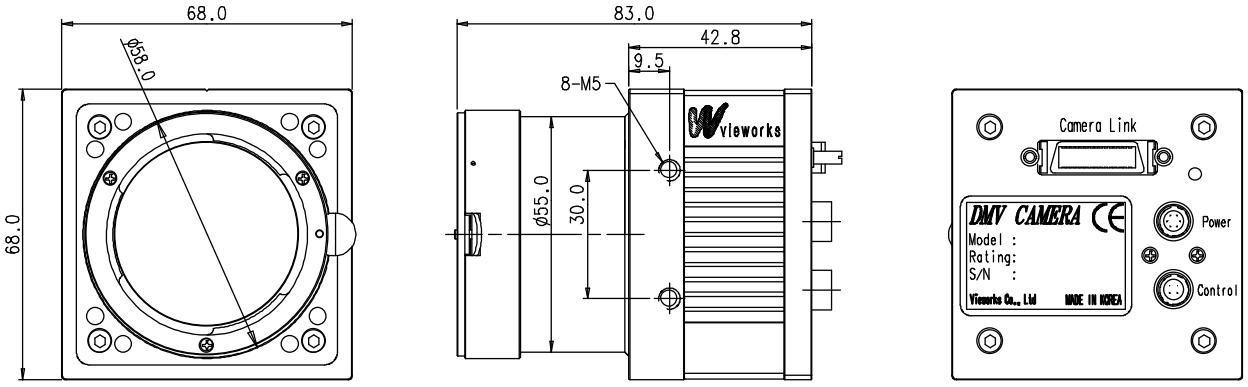


Fig 12.1 VH-5MC Mechanical Dimension (F-Mount)

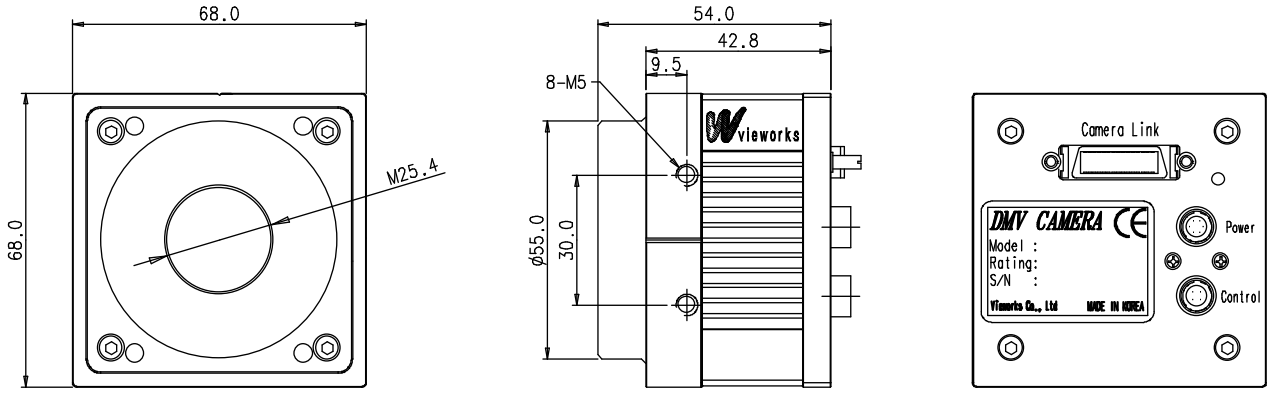


Fig 12.2 VH-5MC Mechanical Dimension (C-Mount)

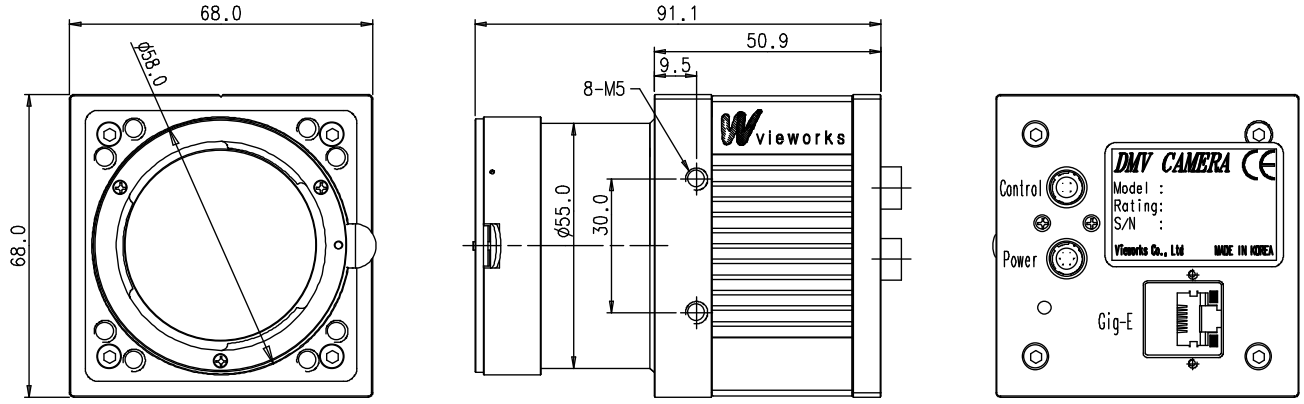


Fig 12.3 VH-5MG Mechanical Dimension (F-Mount)

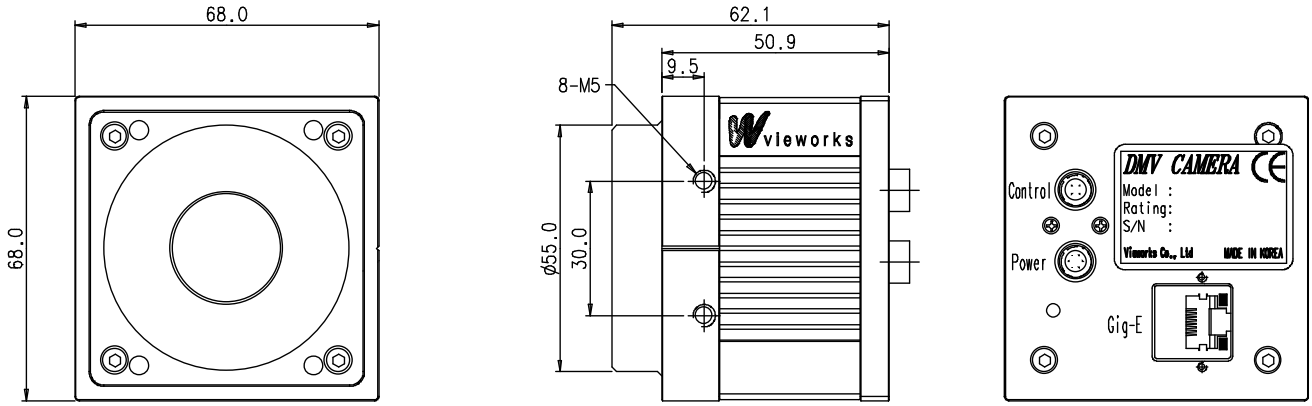
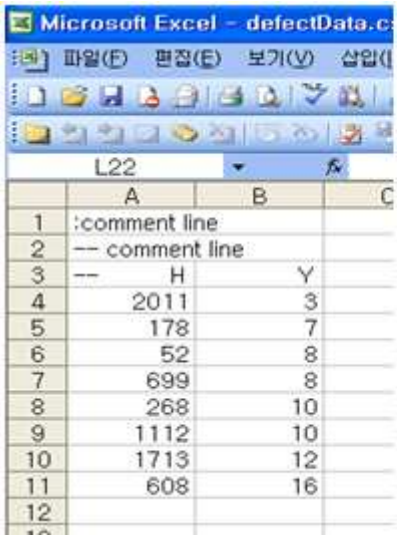


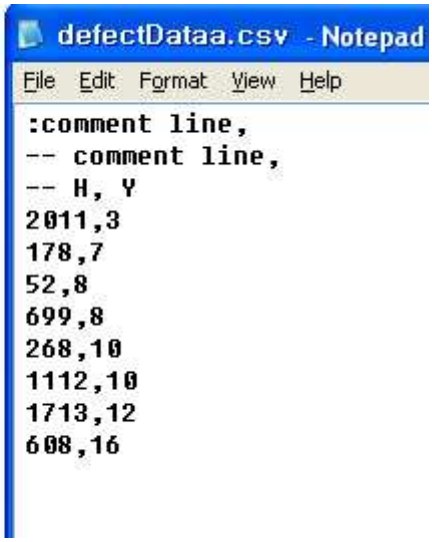
Fig 12.4 VH-5MG Mechanical Dimension (C-Mount)

Appendix A. Defective Pixel Map Download

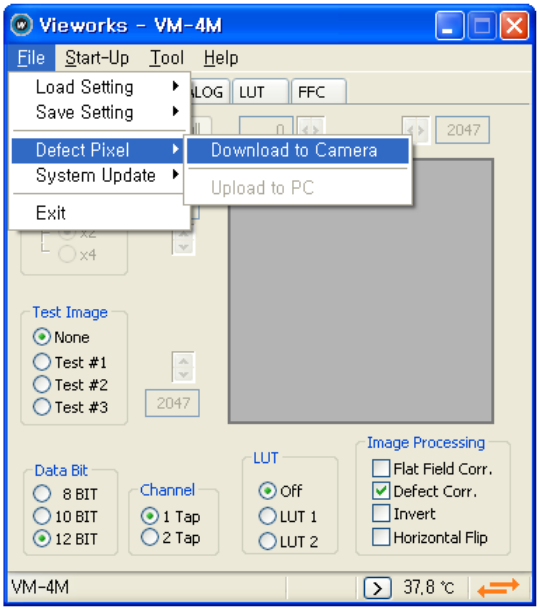
1. Produce the Defective Pixel Map data in Microsoft Excel as shown on the left picture below and save as a CSV file (*.csv). The picture on the right shows the produced Excel file opened in Notepad. The rules applied during the production are as follows:

- Lines beginning with ':' or '—' are treated as notes.
- Each row is produced in the order of the horizontal and vertical coordinate values.
- The input sequence of pixel is irrelevant.

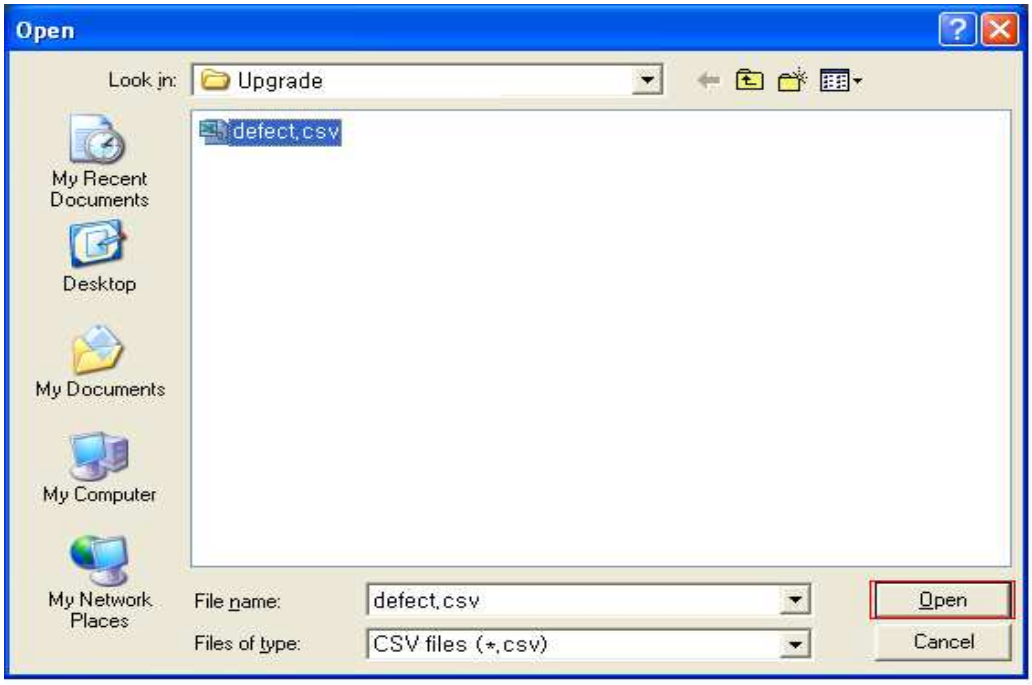




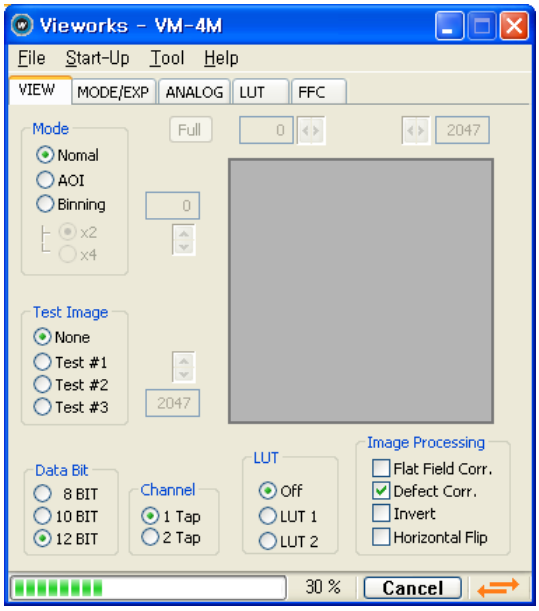
2. Select "File -> Defect Pixel -> Download to Camera" from the program.



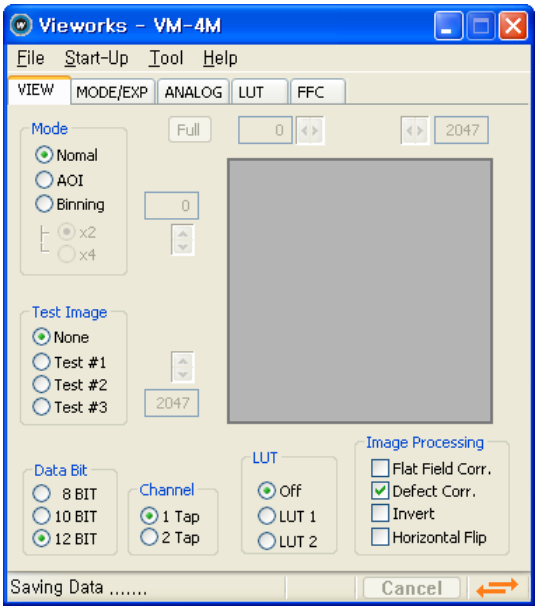
3. In the file dialogue window, select the produced file and click the Open button.



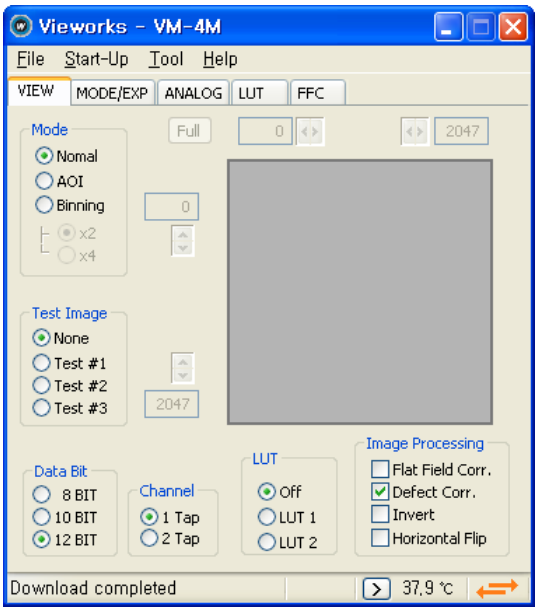
4. The transmission to the camera starts and the transmission rate is displayed at the bottom of the window.



5. Once the transmission is completed, the “Saving Data....” message will appear at the bottom of the window and the saving process will begin. During the saving process, make sure not to disconnect the power line.



6. Once all the processes have been completed, the “Download completed” message will appear at the bottom of the window.

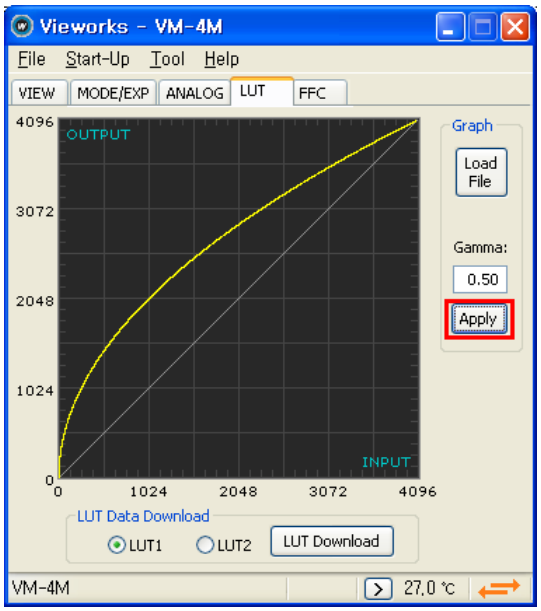


Appendix B. LUT Download

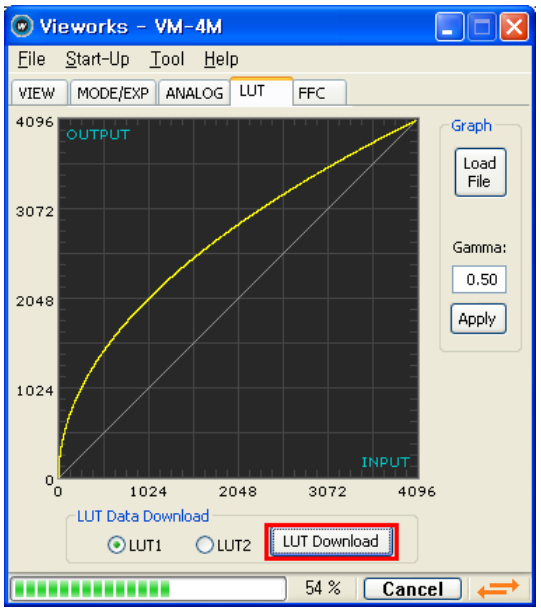
LUT data can be created in two ways: by adjusting the gamma values on the gamma graph provided in the program and downloading the data, or by opening a CSV file (*.csv) and downloading the data.

B.1 Gamma Graph Download

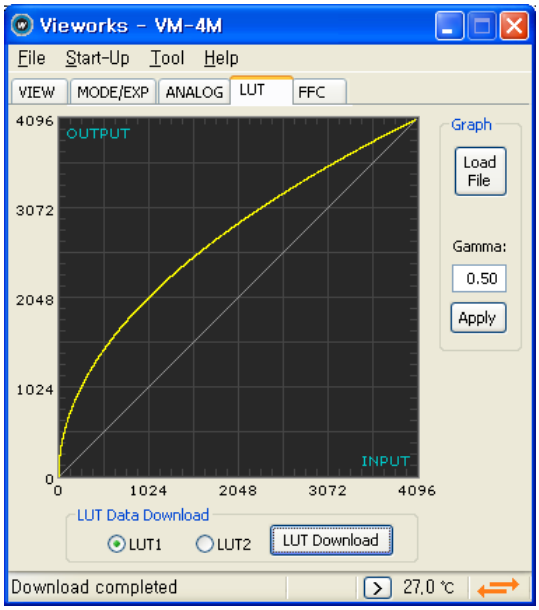
1. Set a desired gamma value on the LUT tab and click the Apply button.



2. Select LUT1 or LUT2 as a location to store the data, and then click the LUT Download button.



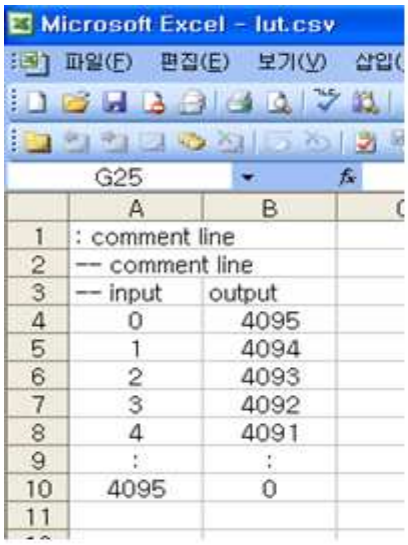
3. Once the download has been completed, the “Download completed” message will appear at the bottom of the window.

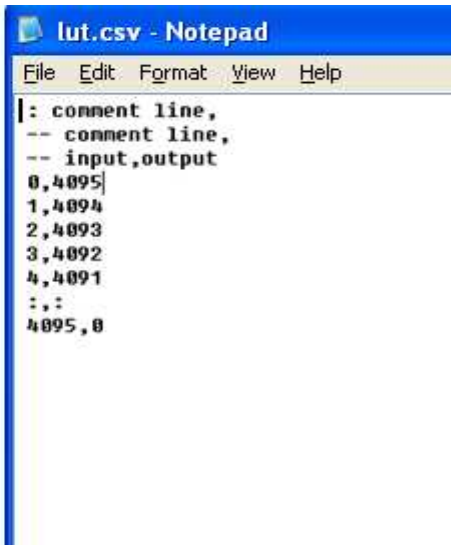


B.2 CSV File Download

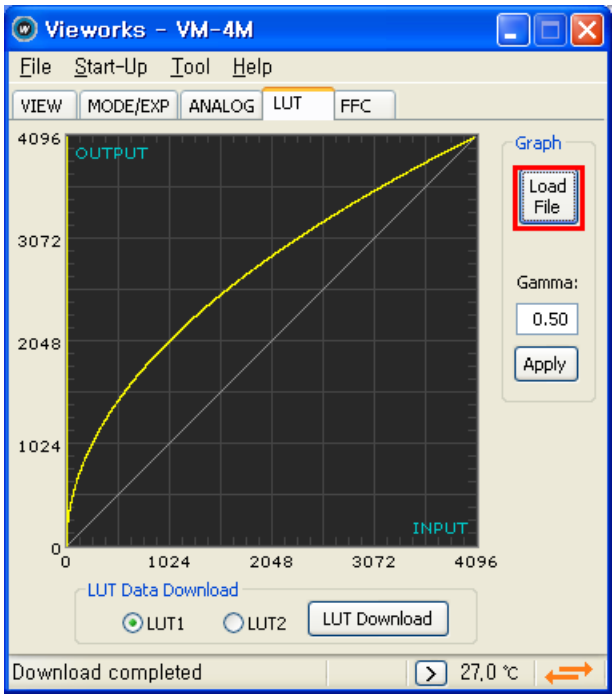
1. Produce the LUT table in Microsoft Excel as shown on the left picture below and save as a CSV file (*.csv). The picture on the right shows the produced file opened in Notepad. Once the file has been produced completely, change the file expansion of the CSV file to .lut. The rules applied during the production are as follows:

- Lines beginning with ':' or '—' are treated as notes.
- Based on the input values, make sure to record from 0 to 4095.

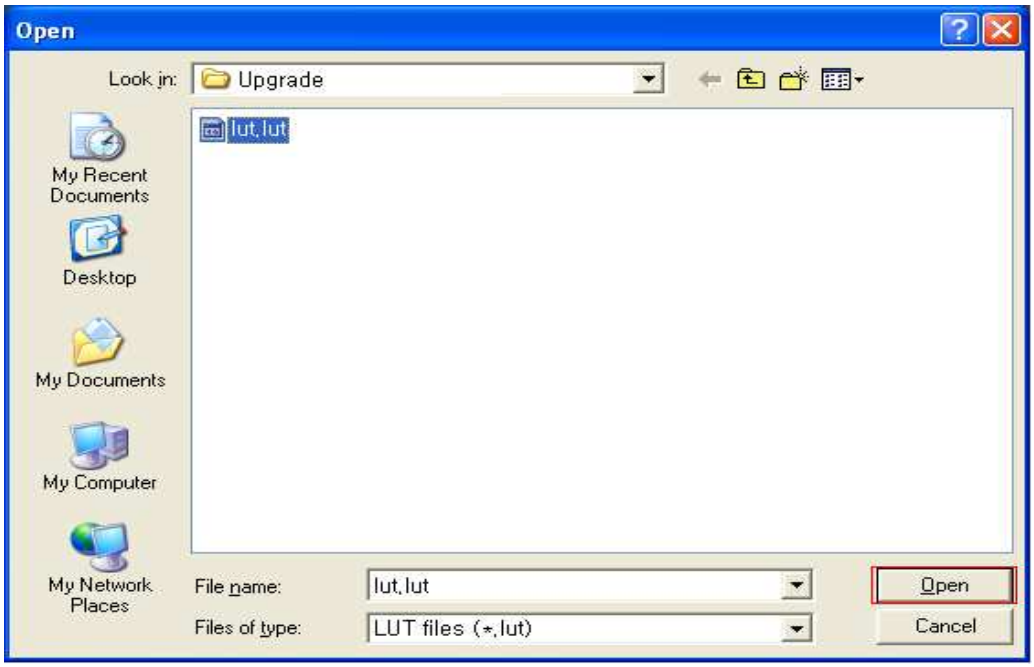




2. Click the Load File button on the LUT tab.



3. In the file dialogue window, select the produced LUT file and click the Open button.

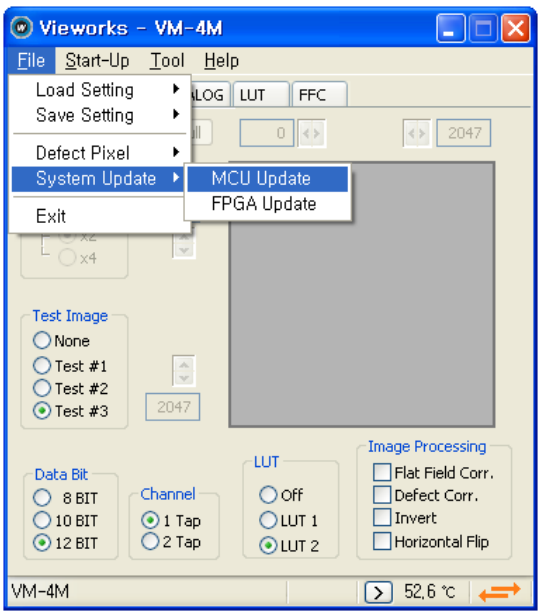


4. Select a folder to save the file, and then click the LUT Download button. From hereon, follow the procedures described under the Gamma Graph download process.

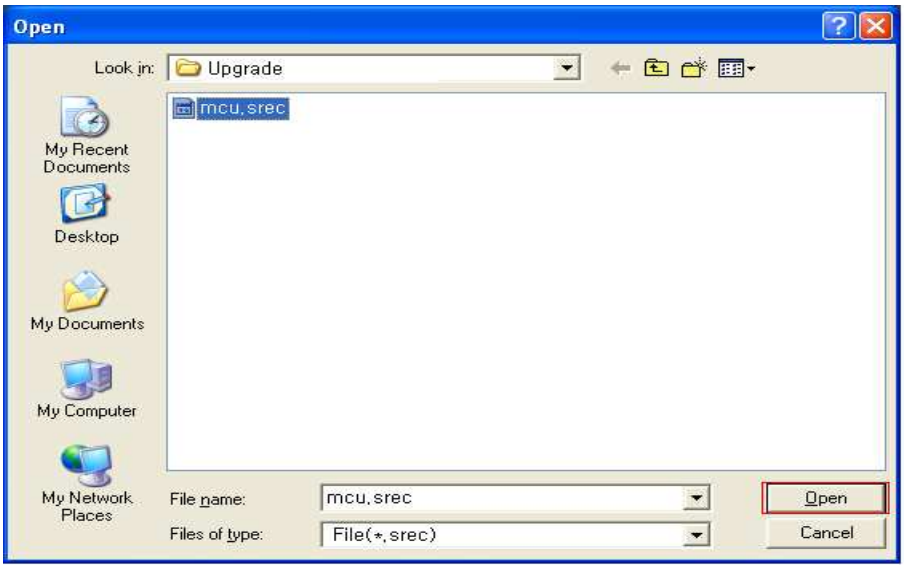
Appendix C. Field Upgrade

C.1 MCU

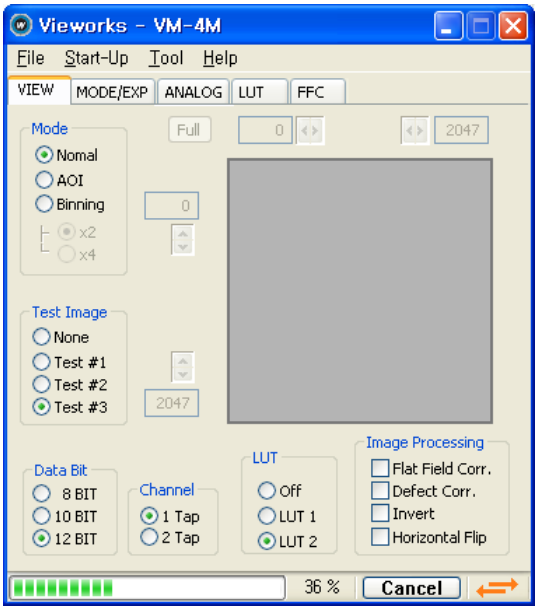
1. Select “File -> System Update -> MCU Update” from the provided program.



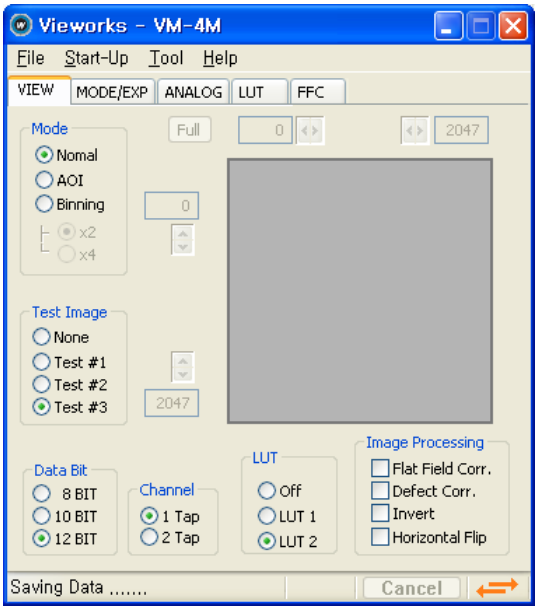
2. In the file dialogue window, select the provided MCU update file (*.srec) and click the Open button.



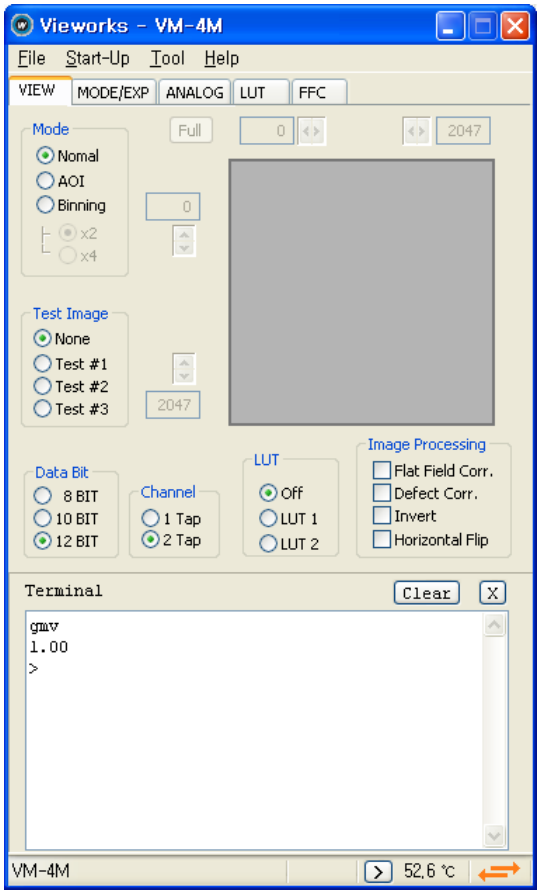
3. The download process is indicated at the bottom of the window. If you want to cancel the upgrade process, click the Cancel button. This process requires several minutes to perform.



4. Upon completion of the upgrade file download, data will automatically begin storing onto the Flash. During this process, the camera cannot be restored if a power failure occurs so make sure that the power line is secured.

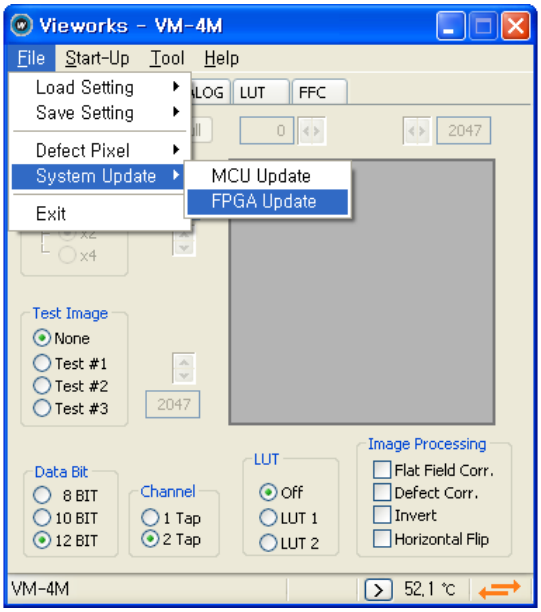


5. Once the download has been completed, turn the power off and turn it back on again. Select “Tool -> Terminal” and enter the “gmv” command to confirm the version.

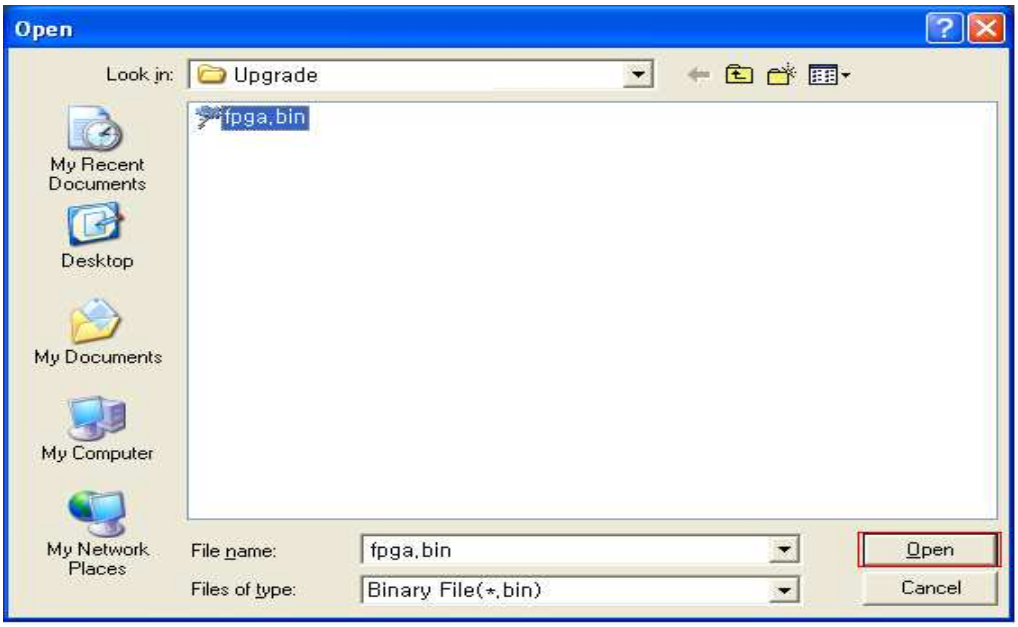


C.2 FPGA

1. Select “File -> System Update -> FPGA Update” from the provided program.



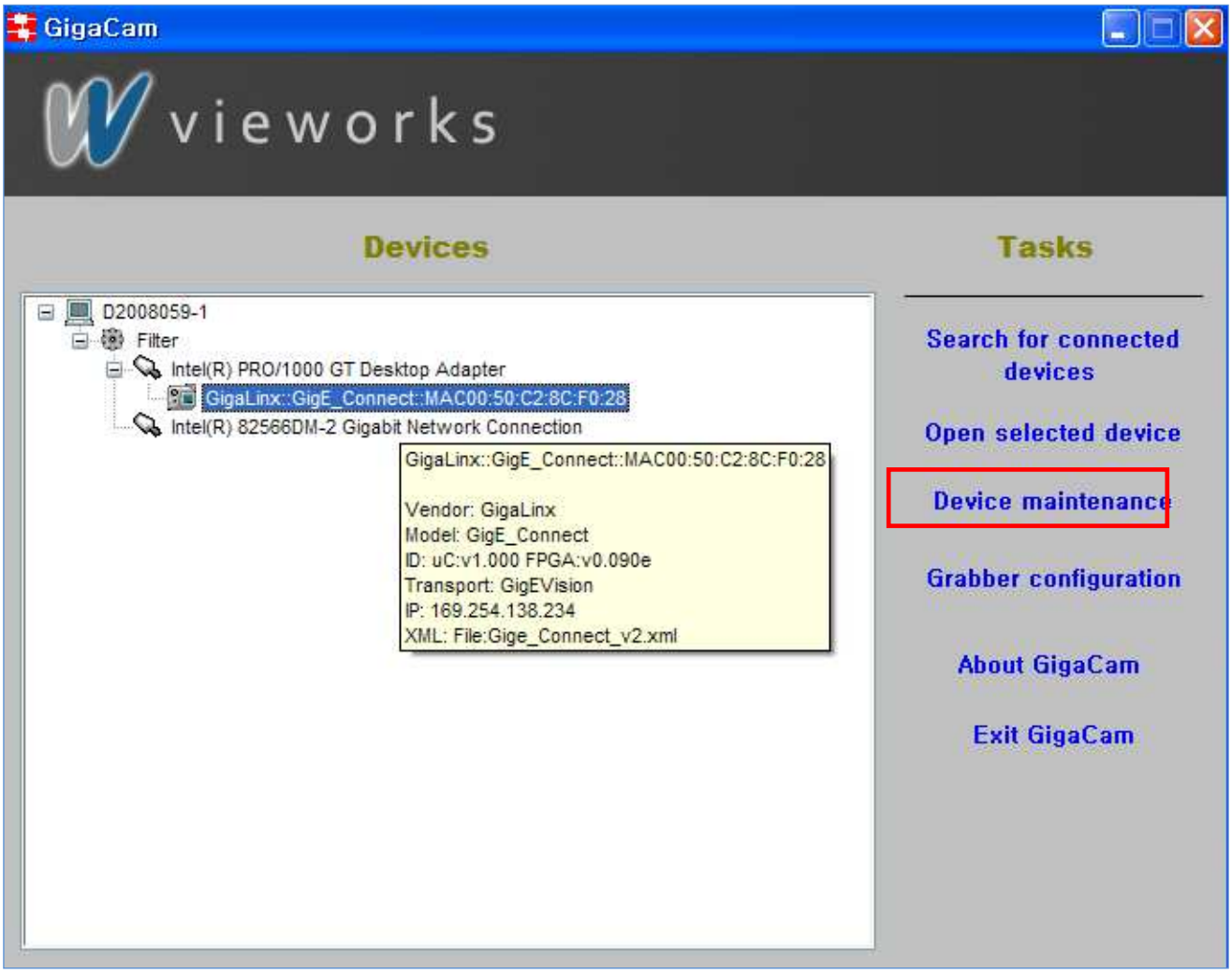
2. In the file dialogue window, select the provided FPGA update file (*.bin) and click the Open button.



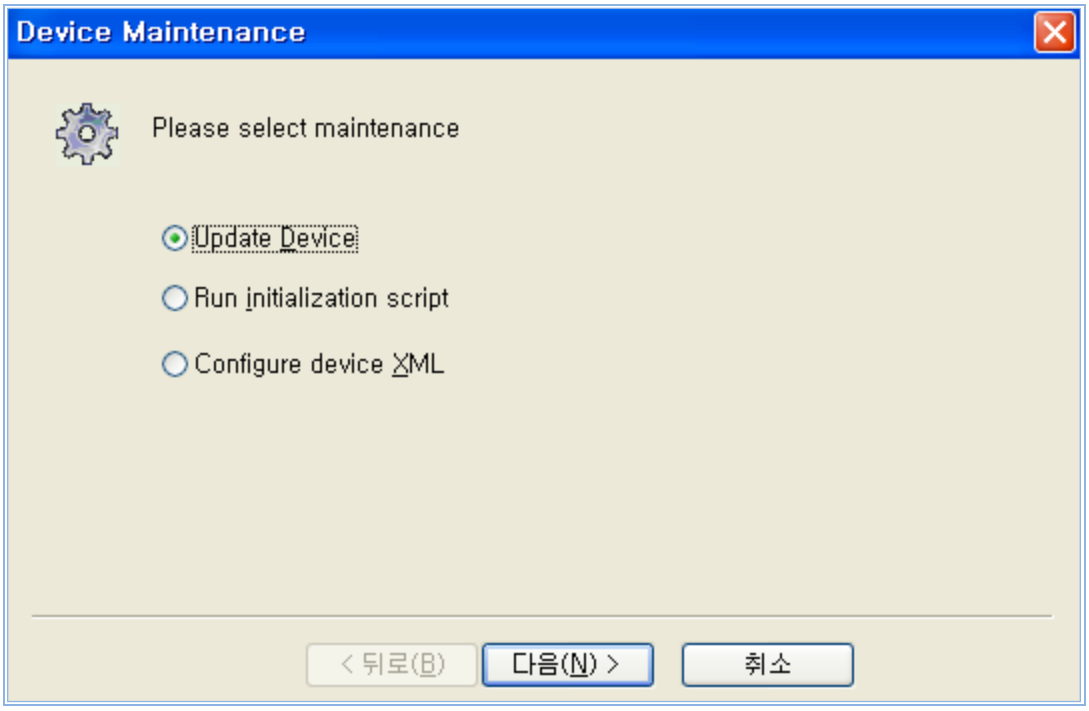
3. The subsequent processes are identical to those of the MCU upgrade.

C.3.1 GigE (MCU & FPGA)

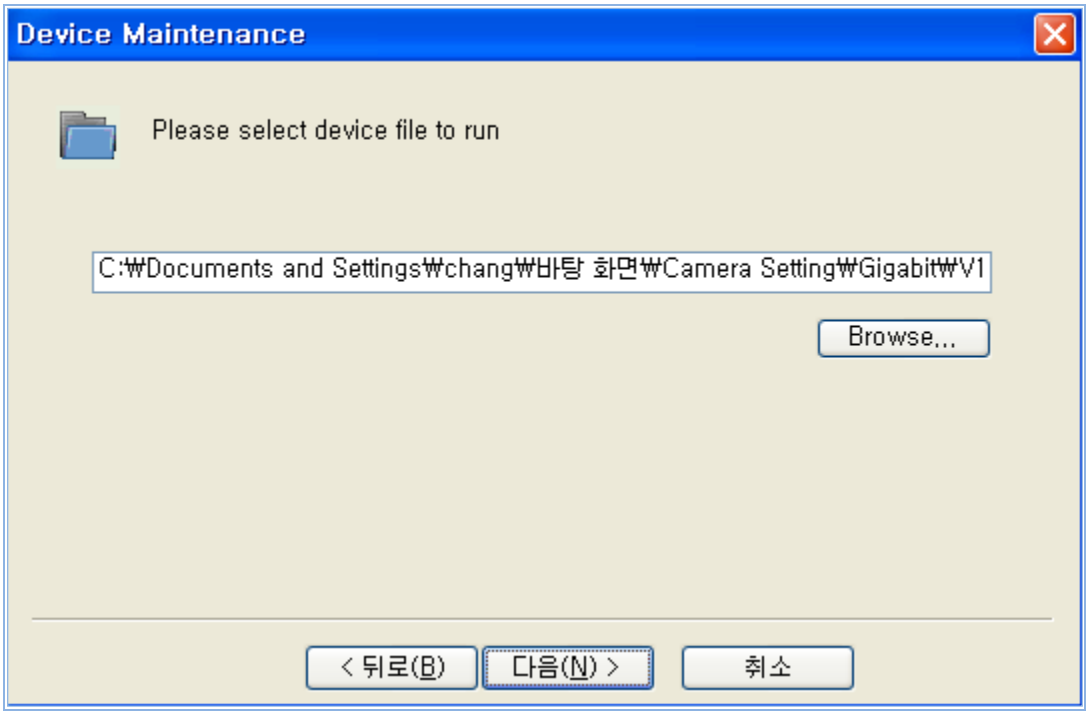
1. Select Device Maintenance



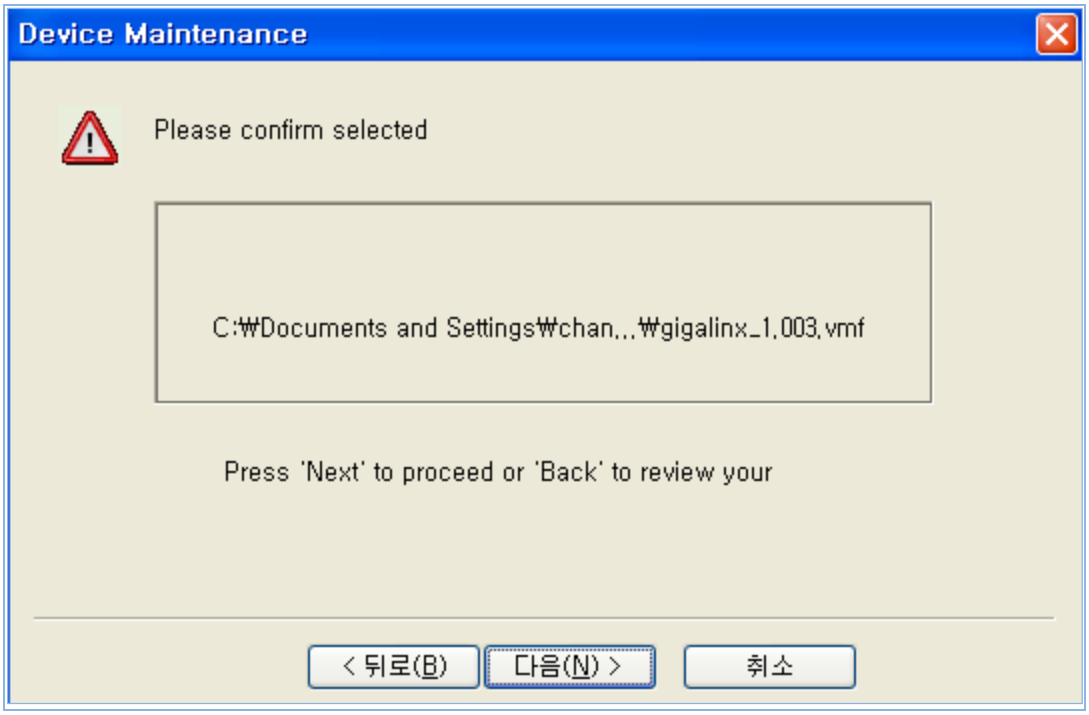
2. Select Update Device



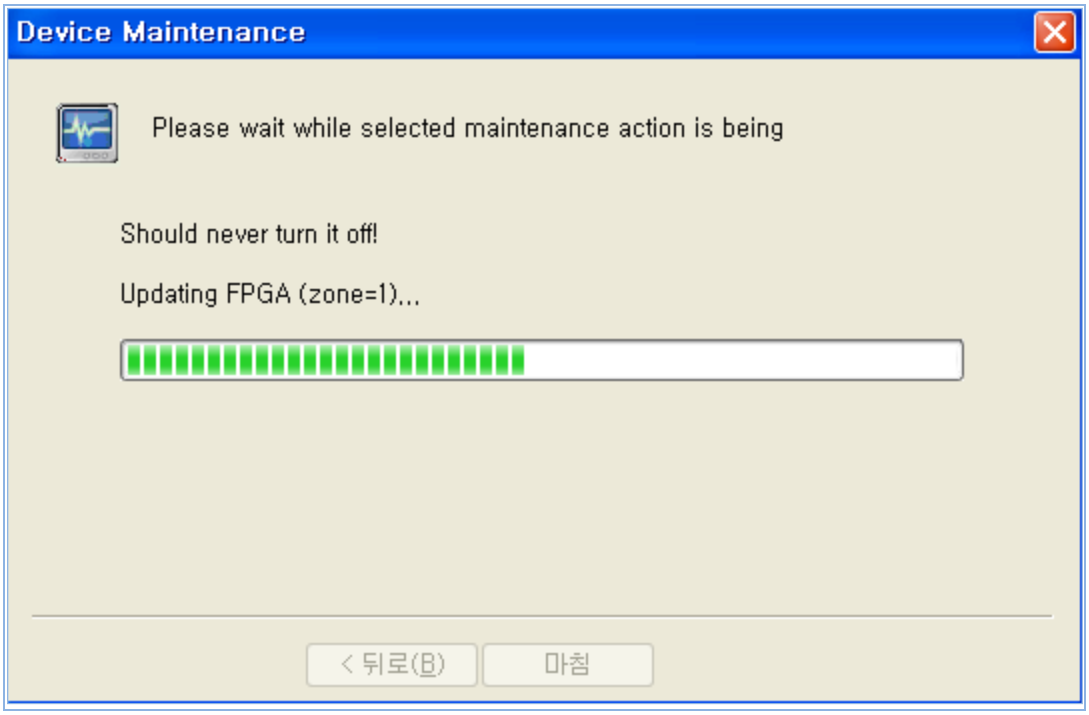
3. Designate path for destination file



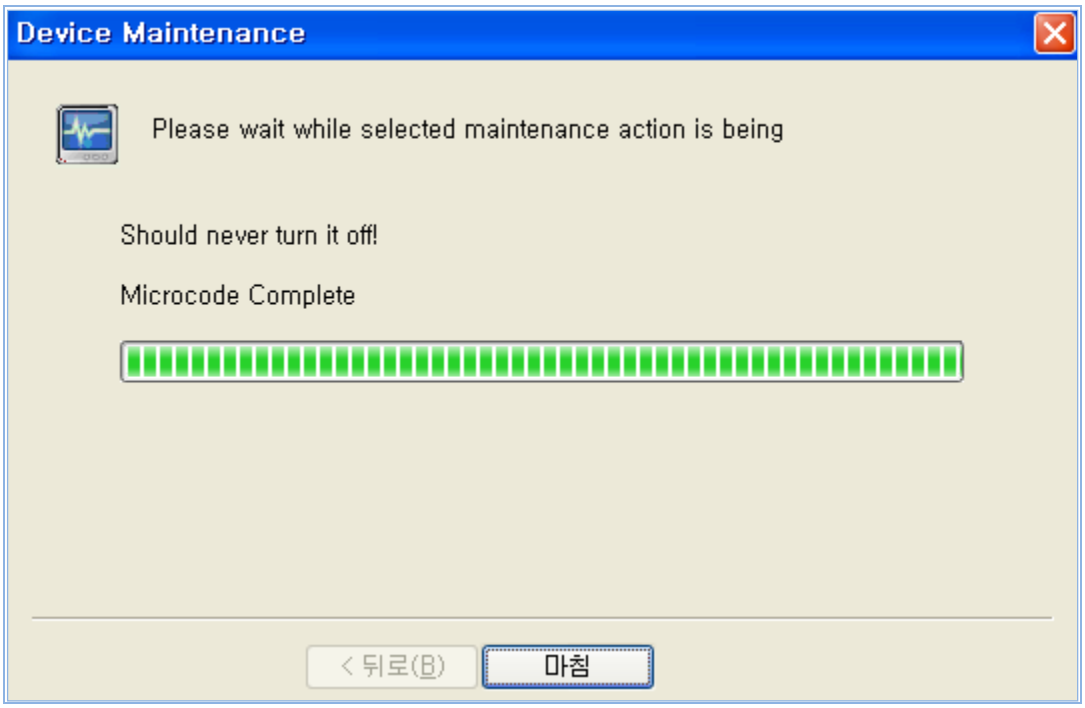
4. Check Path



5. Upgrade



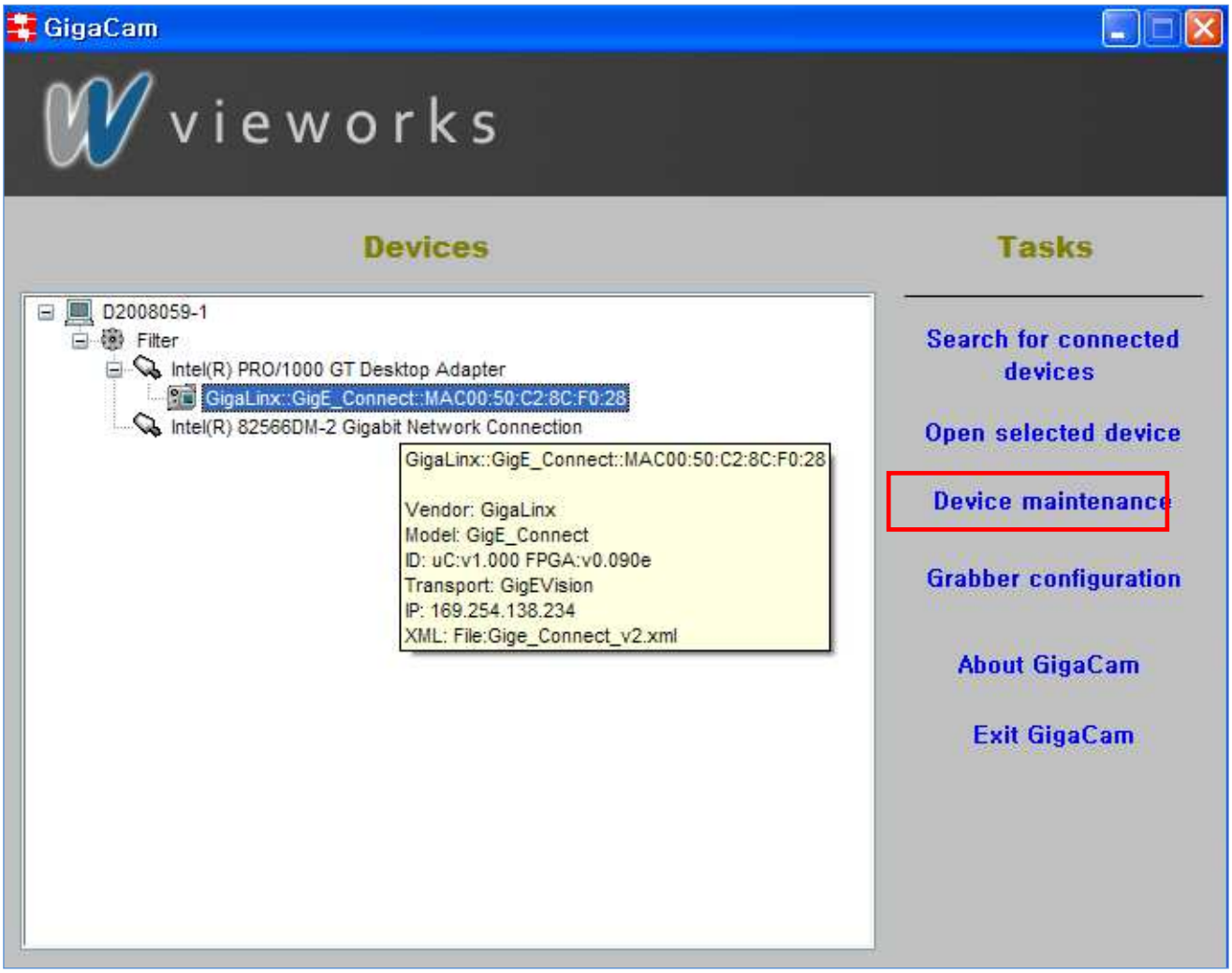
6. Finish Upgrade



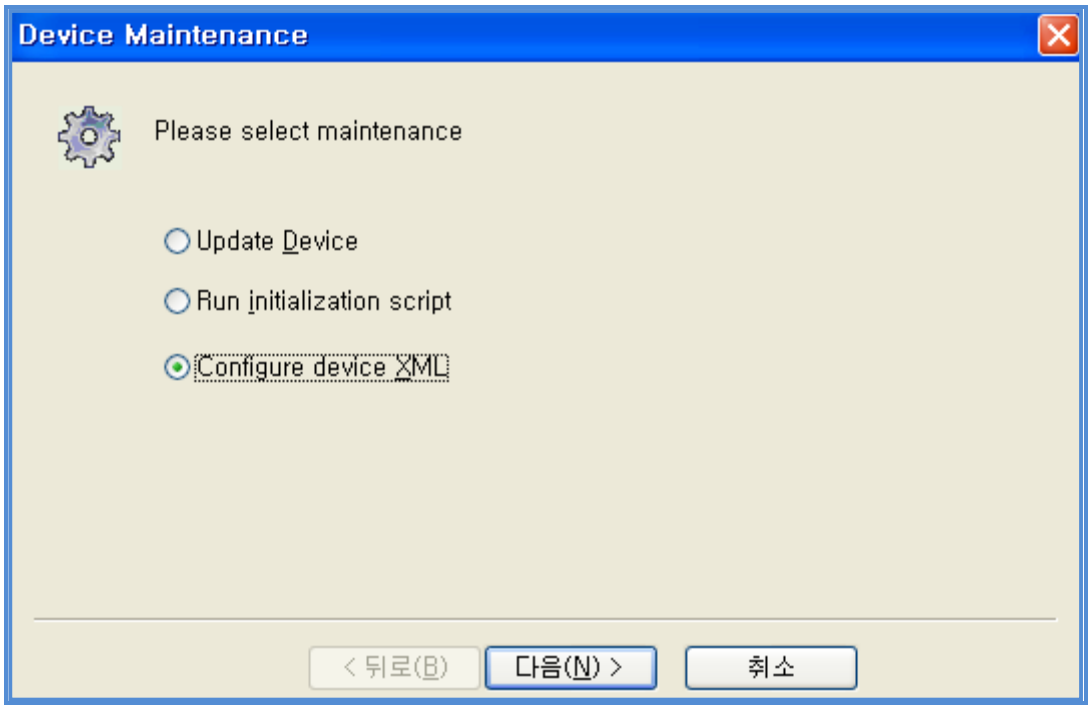
- Finish
- Power off -> on

C.3.2 GigE (XML file)

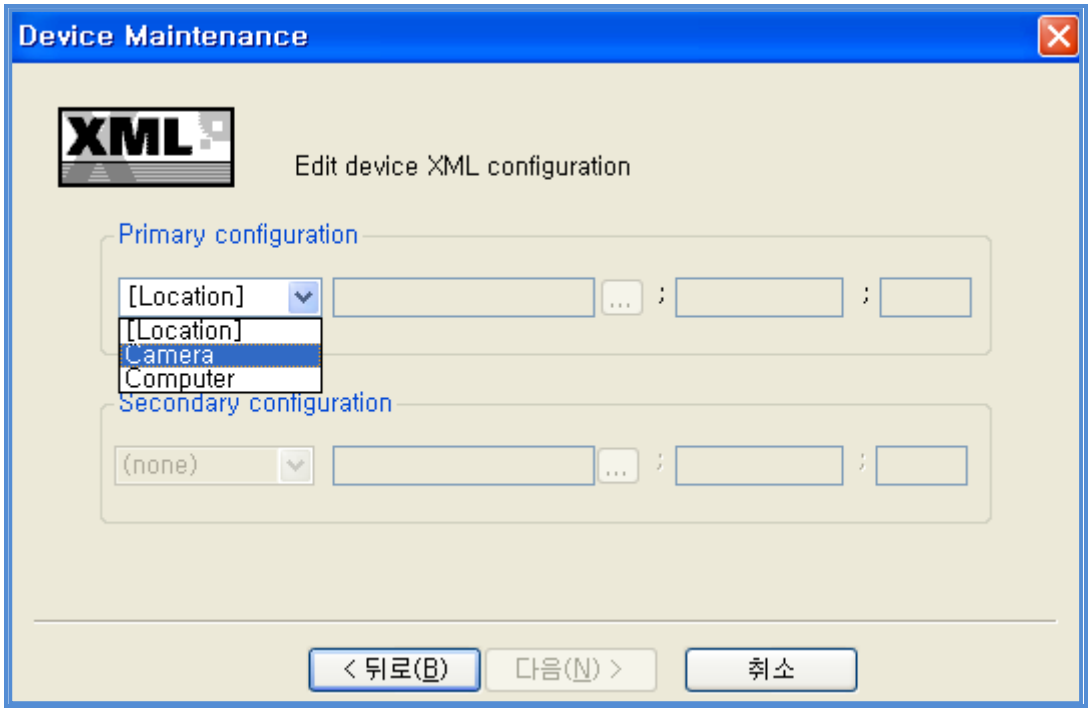
1. Select Device maintenance



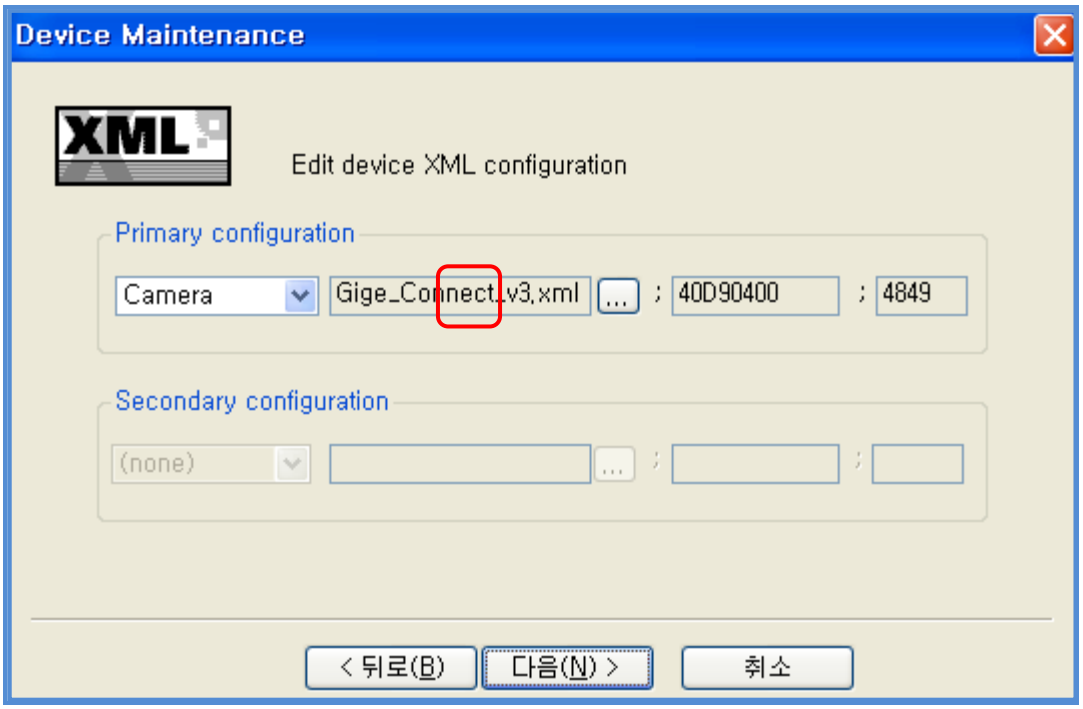
2. Select Configure device XML



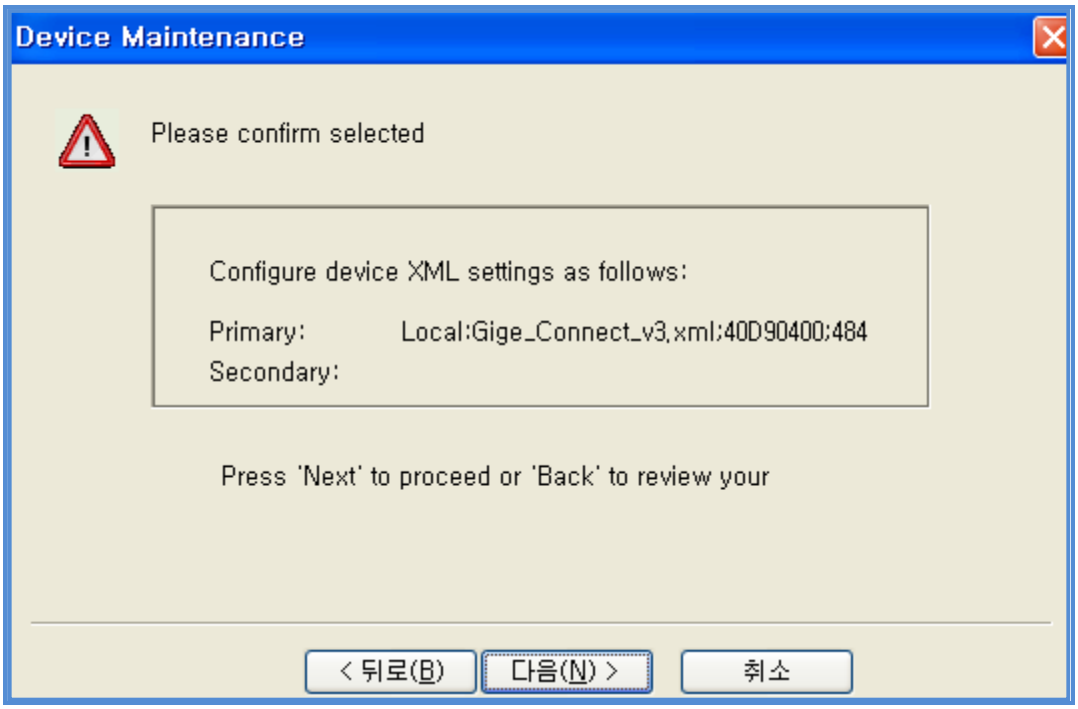
3. Select [Location] Camera



4. Designate XML file path



5. Check Setting value



6. Finish Upgrade